Optimum Distribution of Fertiliser inputs with Special Reference to Haryana

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CONTENTS

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I

INTRODUCTION

[illegible]

1.1 One of the fundamental problems facing the world today, especially in the developing countries is the [illegible]. How will the world feed the 3 billion people, who are expected to join the population between now and end of this century ? When we bear in mind the hunger and poverty of the major portions of this population, the problem takes on some urgency.

1.2 The recent debates in the rich countries have further pin-pointed the dilemma of poor and thickly populated countries of South-East Asia and Africa. There is a school of thought which considers that the exploding populations of these countries have over-run their economic resources and we have heard much talk of the ethics of the "triage" or "life-boat philosophy". This instructs the people of the developed countries to abandon certain "Basket Case" Nations and be ready to repel

"boarding parties" of the desperate poor. The conclusion that we in India must draw from this offer of selective help only to some poor countries and denial of any aid to other countries whose prospects of survival are nil- the choice between them to be made by the rich nations- is that we must not look to foreign aid in the agricultural field with any degree of confidence.

1.3 It is perhaps unfair to focus upon one side of controversy. Indeed, there are quite a few other economists in the developed countries,who have pointed out that it is not that the people of the under developed countries have out grown their resources but rather that the subsistence- agriculture technology that they have followed since hundreds of years is no longer able to support them. Calculations made by the F.A.O. and other bodies have by conservative estimates demonstrated that the agricultural technology as presently known could support a world population of 45 billion if it could be applied to all lands now in cultivation. The world population was 2 billions in 1930, reach 3 billions in 1960 and is projected to be 6 billions by the end of the century.

So it has been pointed out that just at present, therefore, the [illegible] measures of the Life Cost Tables are not applicable. On the other hand, the actual rate of population increase appears now to be reaching a peak and the world-wide rate of foodgrains production has been, generally, [illegible], keeping up with the population growth.

1.4. Perhaps some idea of the shortages involved would be possible if we consider the report of Lester R. Brown of International Food Policy Research Institute. In his 19[illegible] paper, Brown noted that before 1940 the less developed countries had all along been noted as exporters of foodgrains to the more industrialised nation. By World War II, however, they lost their surplus and the net flow was reversed. The export of grains from the developed countries rose from an average of 4 million tonnes a year in 194[illegible] to 29 million tonnes in 1964 and almost all the inter-regional grain exports came from U.S.A., Canada and Australia. (Figure According to the International Food Policy Research Institute, the foodgrains deficit of developing countries

for market economies will be about 100 thousand million tons a year by 1985-86. This is a very optimistic projection. But they warn that the annual deficit could reach to the staggering [illegible] million tonnes.

1.5 Therefore, every now and then the surplus stocks of a few countries have to be drawn down to meet the crisis of calamitous famines due to drought or flood in a number of countries. It is both possible and necessary in the view of these economists, therefore, that the best technology be applied to improve agricultural productivity.

Agricultural Systems:

1.6 To understand the kind of action that is required, it is helpful to consider the stages through which the agricultural systems move and the transformation of the current decades. Traditional farming systems, such as we have in India, involve only the man, his animals, his seed and his land, with little need for co-operation from Government or any other group of people. Consequently the productivity of such systems is limited by soil fertility and climate, and family income in each or

is what depends in part on the size of the farm operation that can be handled with family labour. This is what figures in our text-books as subsistence farming even though it may produce, and in India has produced marketable surplus. Unfortunately, this surplus is not adequate to feed the urban population. The technology that is sought now to be introduced has been popular in the West in the past 75 years or so. It is dependent mainly upon the introduction of more efficient crop varieties, the application of chemical fertilisers and means for controlling diseases and insects and pests. In the case of the West, this type of commercial agriculture has gone along with more farm machinery and industrialised farming and other agri-business rest on a sound foundation of extensive road network, electric power and communications.

1.7 We cannot, in India, without present savings and consumption structure, reproduce in toto the technology of the West. In adopting this technology, therefore, we have concentrated initially on crop varieties. This is what is known by the term Green Revolution. Our experience with it is not very long, hardly a dozen years.

Crop selection

1.8 The [illegible] agriculture relies on eleven different plant species for 90 per cent of its food supplies. The crop selection, however, is not as narrow as this implies. There are, in fact, enough alternatives. In the event of one crop failing, another crop may be grown almost immediately with some success. The real constraint is threefold. First, the farmer must have a clear perception of event, that is to say, that he must be alerted immediately to the possibility of the failure as soon as it happens. Second, he must be willing to change and he must have the alternatives clearly set out before him. Third, he must have the ability to change; in other words, there must be a great deal of speed in making the change. Provided these three important conditions are satisfied, failure of crop due to drought or flood does not imply loss of the whole cropping season.

1.9 The initial crop selection and knowledge of alternatives are the result of an integration of the economic and ecological factors, that is to say, the farmers [illegible] both the risks and returns. The crop

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selection must not only be well adapted to the environment so that it carries few risks of failure; with this provide the yield should be as high as possible. But merely these ecological factors are not enough. The economic aspects are just as important. The crop must fit well into the plan of farm management and it must find a good market for a high income. The problem of management is simplified when the farmer centres his operations round low - risk systems. This may require, paradoxically, minimum diversity. With only a few crops the farmer gains confidence due to experience and education. Spreading risks from diversification may only mean that some part of the system is always vulnerable to unfavourable climatic conditions, market loss etc. Spatial diversification as it is carried out in the past, i.e. different crops in different areas, is not suitable for our country other than for purely ecological reasons. We have attempted more industry diversification, that is to say, number of crops on the same land, as this distributes the need for labour throughout the year and is at all times labour intensive.

1.10 [illegible] significantly by technology. [illegible] can be used to improve the level of agricultural [illegible] by increasing the [illegible] of [illegible] used for instance. [illegible], artificial [illegible] [illegible] particularly in [illegible]. Secondly, the new technology can be used to [illegible], that is to say, it may also be used to [illegible] the [illegible] risk at the [illegible] level. For instance, the grain driers, installed to meet the [illegible] of wet conditions [illegible] the [illegible] varieties of grain [illegible], can [illegible] every year to longer-season varieties that have a better yield.

Factors determining agricultural yield.

1.11 The factors that determine agricultural yield are complex. There is no basis in the widely held opinion that the photosynthetic ability of the plants is the main factor. [illegible] the photosynthetic potential for crops is only [illegible] utilized because of [illegible] of nutrients, [illegible] and temperature. [illegible]

[illegible] probably [illegible] agriculture on a large scale. [illegible] production [illegible] of [illegible] suitable agricultural [illegible] equilibrium with [illegible] of plant nutrients. [illegible] major [illegible] inorganic nutrients [illegible] in mind the supply of soil [illegible] for the world, as a whole the area of [illegible] and highly fertile soil is quite small. At present the chief limiting nutrient in agriculture is nitrogen. Crop plants in many situations can utilize more nitrogen than they are likely to receive from natural sources. The record for annual production of biomass by any plant (a tropical grass that yielded than more 80 tonnes of dry matter per hectare) involves the assimilation of more than 1600 kgs. of nitrogen. In India, previously an attempt to add to the soil nitrogen was through the growing legumes. Legumes, however, are low yielding crops and the amount of nitrogen given to the soil is [illegible]. With the advent of ammonia fertilizers, the progressive farmers in India have switched to artificial fertilizers and cereals are preferred to legumes as rotation crops.

1.11 [illegible] clearly [illegible] the average [illegible] in [illegible] of Japan. In Indonesia, in [illegible] of rice per year [illegible] of hectares [illegible] 21 [illegible] yield [illegible], only [illegible]. For each area of rice [illegible] only [illegible] of the average yield for Japan. The discrepancy is due not to deficiency of human effort, since an standard [illegible] maintained in Indonesia in such matters as the control of [illegible], but to deficiency in plant nutrition. [illegible] the system is in a steady state, the simple nitrogen budget indicates that about [illegible] kg. nitrogen per hectare is removed from the land each year in grain and straw. In Indonesia, the average consumption of chemical nitrogen was only 11 kg. per hectare. Thus if we assume that rainfall contributes [illegible] kg. per hectare of nitrogen per year the total amount of nitrogen [illegible] to compensate for losses would be [illegible] kg. [illegible] the fertility of the soil can be [illegible] and it becomes less vulnerable to year to year fluctuations.

The [illegible]

1.13 The [illegible] plain. [illegible] factors [illegible] conditions than [illegible] with the [illegible] emphasis. [illegible] and other [illegible] difference in form, [illegible] and intensity of production. The effect of natural factors could be modified to a large extent by the type of technology employed in the new project. For instance, if the lack of moisture is a problem the cropping pattern can be adjusted or irrigation can be provided. The strategy, therefore, should be to provide the means of production according to the new technology and the present study aims at establishing the conditions under which this may be done.

1.14 The type and amount of technology adopted are a function of the conditions [illegible] and rural system. Different resources are emphasized in different systems. Japan emphasizes the amount of sunlight by

supplying nutrient to achieve high yield selecting a short season crop. We tend to optimise a scarce resource associated with land. United States technology reflects the optimisation of labour in a social environment where land, energy and capital are cheap. Agronomists have pointed out that intensive systems like rice are relatively safe provided that they receive maintenance research and high priorities for land and energy.

1.15 We should note further that our system – an intensive system – is highly responsive to market conditions. The production that cannot be channelled to market has little value to the society. One result is that production is strongly constrained to match demand. The management decision on the amount of land given to each crop, on the varieties of crops, on the use made of the crop and even on the level of farming efforts may change over a considerable range from year to year. It is regrettable that little incentive to increase production is given to farmers in India though our need for foodgrains is high

To satisfy urban needs we have found it necessary to maintain policies favouring low cost for food and inevitably therefore a low return to the farmers. It has been possible to do this because the food markets of the world have been depressed for a century by the abundant production of American agriculture. PL 480 wheat sustained our low price policy with care and efficiency being doubly popular because it provided the Government of India with a cushion for its deficit spending. One result is that little can be deduced about the potential behaviour of farmers and farming systems in this kind of situation. However, since President Johnson's 'Ship-to-Mouth' policy, we became aware of the vulnerability of our dependence on food imports. Since then the elasticity of supply of the foodgrains market has been found to be satisfyingly high. Food systems are not merely dependent on natural factors but also on human institutions and in India we must guard against the policy of benign neglect of agriculture which we followed for quarter of a century.

SETTING THE PROBLEM

1.16 As we have stated already, there is a shortage at present i.e. during the last 10 years both of foodgrains and agricultural cash crops e.g.cotton, oil seed, sugar cane, etc. This is evidenced by the net import of both foodgrains, i.e. wheat, rice and coarse grains as well as cotton, rubber, etc. It is further evidenced by slackness of export, obviously due to supply constraints, of jute, sugar, fine rice, tea, etc.

1.17 The so-called Green Revolution which showed its effect on the production of wheat in the latter half of the nineteen ~~sixteen~~ sixties was based on the use of High Yielding Varieties of seeds which are extremely tolerant towards large doses of nitrogenous fertilisers. In the first year of operation(1967-69) this new agricultural strategy yielded a record production of 95.05 million tonnes of food grains. Since then foodgrains production in India has been steadily increasing except in the year 1968-69 when only 94.01 million tonnes were produced.

1.18 While the progress in attaining self-sufficiency in foodgrains is remarkable, India has not been able to keep pace with the increase in population. While the production of foodgrains, for instance, was satisfactory in 1975-76 and 1976-77, the production is said to have fallen by some million tonnes this year. A plan for a buffer stock of 12 million tonnes is mooted to provide stability in wholesale prices, the index of which has risen from 145 in 1970-71 to 160 in November, 1977.

1.19 At the present rate of population growth, we require at least 2 million tonnes of additional foodgrains every year, to attain self-sufficiency in the very minimum sense of keeping the per capita consumption of foodgrains at the present - rather low-level. If we were to provide nutritionally adequate diet, then of course, the production would have to be increased even more, since it is well established that the average diet falls short in total calorie intake rather than selective shortage of protective foods.

1.20 As far as other agricultural commodities are concerned, it is a fact that we face a very competitive situation for both our major exportable textile raw materials i.e. cotton and jute. While cotton is also required for domestic purposes, both high grade cotton and jute are our major foreign exchange earners. They compete with foodgrains for agricultural inputs including land.

1.21 It is well-known, that cultivable land has been almost wholly utilised in India and any extra production can only come from more inputs intensively used on land. In fact, there has been in the last two decades, a sharp fall in forest cover and today there is much less over than desirable. We keep ourselves open to the well-known dangers of soil erosion and general ecological disturbances. The only way in which supply of cultivable land can be increased is by cultivation of dry semi-arid areas, the technology for which is being worked out.

Crucial Role of Foodgrains

1.22 We will, in this study, be primarily concerned with the production of foodgrains, in particular the production of wheat and rice. Since land is the main constraint, the attempt will be to work out the conditions of input intensification and optimisation in order to get the maximum yield of foodgrains from a given unit of land.

1.23 This is important because in the All India Co-ordinated Crop Improvement Projects, it has been observed that the yield maximising levels of nitrogen are significantly higher than the corresponding optimum levels at various locations. The differences in the two levels at some of the centres were as high as 74, 38 and 98 Kgs. per hectare for rice, wheat and maize respectively. Relative prices are, therefore, crucial with regard to both inputs and output.

1.24 We may ask why self-sufficiency in foodgrains is important? Why is it not possible to import food that we require? Apart from the fact already note that foreign food aid has been slowing down gradually,

there are at least three other valid reasons for depending on our own ability to produce food.

1.25 In the first place, bad harvests in the last few years exhausted the world buffer stock of food and had it not been for the bumper harvest that we had in the last two years, we would have found it difficult to import cereals from abroad. This sort of situation has not been unusual in the past and is, in fact, forecast by a number of agronomists as a possible scenario in the next few years. The inability of countries importing and exporting wheat to agree to the terms of renewal of the International Wheat Agreement is a pointer to the shape of things to come.

1.26 Secondly, the rate of increase in agricultural productivity has slowed down considerably in advanced countries though it is still higher than that of India as a whole; as a consequence they have less surplus. Cost of production of food has risen sharply in the West, especially that of meat etc.

1.27 Finally Western countries themselves are experiencing increased indirect demand for foodgrains

for poultry feed or as food for livestock -both meat and poultry being preferred food in their countries. For all these reasons, therefore, we have seen that the price of foodgrains has risen sharply and in any case even in absolute terms, we can no longer count upon filling our consumption gap through imports. Further, one of our best export items is Basmati and other superior grades of fine rice to the Arab countries from whom we expect vital imports like petroleum.

1.28 Another major reason for focussing upon the maximum production of foodgrains is that this is possibly the best way to handle the redistributional aspect of our farmers' income. The majority of farmers hold small acreage. Increased output, which provides them with more income has more immediate impact than almost any other type of effort in helping the poorer sections of the community. In fact, it may be the only way to make a large number of families economically viable.

1.29 Purely from the point of view of maximum

return to investment, the strategy of increasing foodgrains production is a good one. For any given outlay the return to agriculture has been shown to be much higher than that in modern industry. This holds good in spite of the recently increased cost of chemical fertilisers, due to higher price of crude petroleum. It applies a fortiori to coal-based fertilisers and farm yard manure, and is true even when irrigation canals including lift-irrigation is contemplated.

1.30 The market aspects of higher rural income are also important. Foodgrains face a steady demand and incomes are, therefore, assured. This leads to higher demand by the rural population for industrial goods, not only for inputs like fertiliser or seed or labour but also for consumer goods like clothes. The employment aspect, of course, if fairly obvious and it is clearly established that the Green Revolution has led to a higher demand for labour than previously

Supply of Fertilisers

1.31 It is, of course, true that we do not produce adequate amount of chemical fertilisers. The gap

between production and consumption of fertiliser has been estimated by the Fertiliser Association of India for a good year like 1975-76 as 6,40,000 tonnes of nitrogen and 1,47,000 tonnes of P_2O_5. Even in 1978-79 the situation is not likely to change much, in that the nutrient targets for the production of fertilisers for the current financial year have been fixed at only 2.5 million tonnes of Nitrogen and 800 thousand tonnes of Phosphatic fertiliser against targeted consumption of 3.55 million tonnes of Nitrogen and 9,50,000 tonnes of Phosphates. There is no indigenous produnction of potassic fertilisers and the targeted consumption of 480 thousand tonnes will have to be wholly imported.

1.32 The installed capacity for nitrogenous fertiliser in 1981-82 will be 51,00,000 tonnes. To meet the gap between production and consumption it is also proposed to take up for implementation two large-sized nitrogenous fertiliser plants in South Bombay based on associate gas from Bombay High and one plant based on gas from ONGC and Oil India Ltd. fields in Assam. There is also a proposal to be set up two large-sized nitrogenous plants based on gas in Gujarat. A plant based on fuel oil as feedstock is being set up

in the private sector by Nagarjuna Fertilisers at Kakinada in Andhra Pradesh. However, fears have been expressed that further encouragement to the use of nitrogenous fertilisers may aggravate the imbalance and is, therefore, not desirable.

1.33 The position of phosphatic fertiliser is somewhat different because not even 50 per cent of the current installed capacity is being utilised and the capacity will shoot upto 1.31 million tonnes by 1981-82 and the experts have felt that there should be no problem provided the price is right. The sharp rise in prices in 1974-75 resulted in a fall in the consumption by about 27 per cent in the case of phosphatic fertilisers whereas consumption of nitrogenous and potassic fertilisers dropped by 3 and 7 per cent respectively. The price is thus a critical factor in the case of potassic fertiliser. Since we anticipate that the cost of imported fertiliser will be high and that of domestic no better, subsidies may have to be resorted to.

1.34 Nevertheless, given the foreign exchange constraints it is more efficient to spend it on

fertilisers than on foodgrains. At the prices prevalent in 1976, for instance, the return on every rupee invested in nitrogenous fertiliser varied from Rs.3.32 for wheat and Rs.2.34 for rice. While the return to the use of fertiliser and the inputs is probably greater for cash crops than for foodgrains, this may only the result of price fixation policies followed at present which lay undue stress on low price of foodgrains in the interests of urban users.

1.35 Given the fixed land acreage, we, therefore come to the conclusion that increase in foodgrains production would require higher doses of fertilisers, but that fertilisers in the foreseeable future will be a scarce resource.

Objective of Study

1.36 The objective of this study is thus to optimise the use of fertiliser in order to produce either the maximum amount of foodgrains or the highest profit from the production of foodgrains. In order to do this, we have to establish a relationship between land area and fertiliser use

in each State and to establish the technologically optimum amount of fertiliser required for each of the principal food crops. Previous studies tend to estimate the demand for fertiliser by fitting a Cobb-Douglas production function relating per capita foodgrain production - to per capita fertiliser consumption - and per capita land in hectares. They suggest that the per capita fertiliser used per hectare of land appears to be unduly low. We will make an attempt instead to study the response of foodgrains, in particular wheat and rice, to fertilisers, specially nitrogenous fertilisers, as obtained in fertiliser experiments all over India.

1.37 The immediate objective then is first to estimate directly the optimum use of the fertiliser N and P in order to :

(a) maximise the yield of wheat and rice, and

(b) maximise the profit to the farmer on the production of wheat and rice.

1.38 Secondly, we will try to work out the costs of production of these crops in the case of three types of farms, all on irrigated lands, viz.

(1) large farms of 10 hectares or more wholly owned and using tractors and ancillary equipments and employing hired labour - these may be termed commercial farms;

(2) medium farms, 10-5 hectares average size being 4 to 6 hectares with a peasant proprietor using mainly family labour and advanced traditional equipments like iron ploughs and finally

(3) small farms below 4 hectares using ordinary traditional equipments like wooden ploughs.

1.39 Since we find that it is feasible to use chemical fertiliser and High Yielding Varieties of seed on all the farms, the only constraints here being the assured water supply, we will assume that all the farms will be using these inputs. This means that we will not explore here the technology of using

cost of irrigation water, we will mention the relative costs for e.g. (a) canals, (b) wells, both deep and shallow and (c) water lift schemes (like Narmada Cont)

1.40 Thirdly, the objective is to devise a formula which would guide the Government agencies in the distribution of N and P at the district or sub-divisional levels so as to achieve maximum yield. The formula would presumably relate to the:

(a) area under these crops,
(b) the proportion of the area which is under irrigation, perennial or seasonal; and
(c) the size of individual holdings in the district.

1.41 Having established the difference in cost of cultivation, and devised a formula for fertilizer distribution, we will finally suggest price policies which might bring together the output at which the maximum yield per hectare coincides with the maximum profit to the farmer. In this way, we will be able to provide incentives for the maximum production of foodgrains which is an essential condition for

study the extent to which policies followed today by the Government have been efficient or otherwise.

Reason for choosing Haryana

1.42 The choice of the State of Haryana for this study is appropriate because its creation coincides with the introduction of the new agricultural strategy of the so-called Green Revolution and because the farmers of this State have, on the whole, found this strategy acceptable. Further, the State is divided into agronomic regions which provide a wide range of climatic features, from semi-arid regions subject to flooding along the Yamuna river.

1.43 Some of the problems which are present in the State of Haryana are now emerging in other States as well. In most States arable land is already fully cultivated. In fact, the forests cover which is said to be a ecological minimum is not available in Haryana and in quite a few of the southern and eastern States. The necessity for utilising every valuable hectare and maximising the intensity of cropping and is a problem

confronting Haryana at least for the last five years. The choice between mechanising the farms, on the one hand, and using bullocks and lower cropping intensity on the other is a highly controversial question. We must remember that the condition of the soil is almost non-renewable as an asset and we can condemn ourselves to severe problems of erosion and loss of long-term fertility by insisting upon a very high intensity of cropping. For all these reasons both in the choice of fertiliser intensity and in the choice of techniques for small medium and large farms, the example of Haryana is a useful one for the rest of the country to bear in mind.

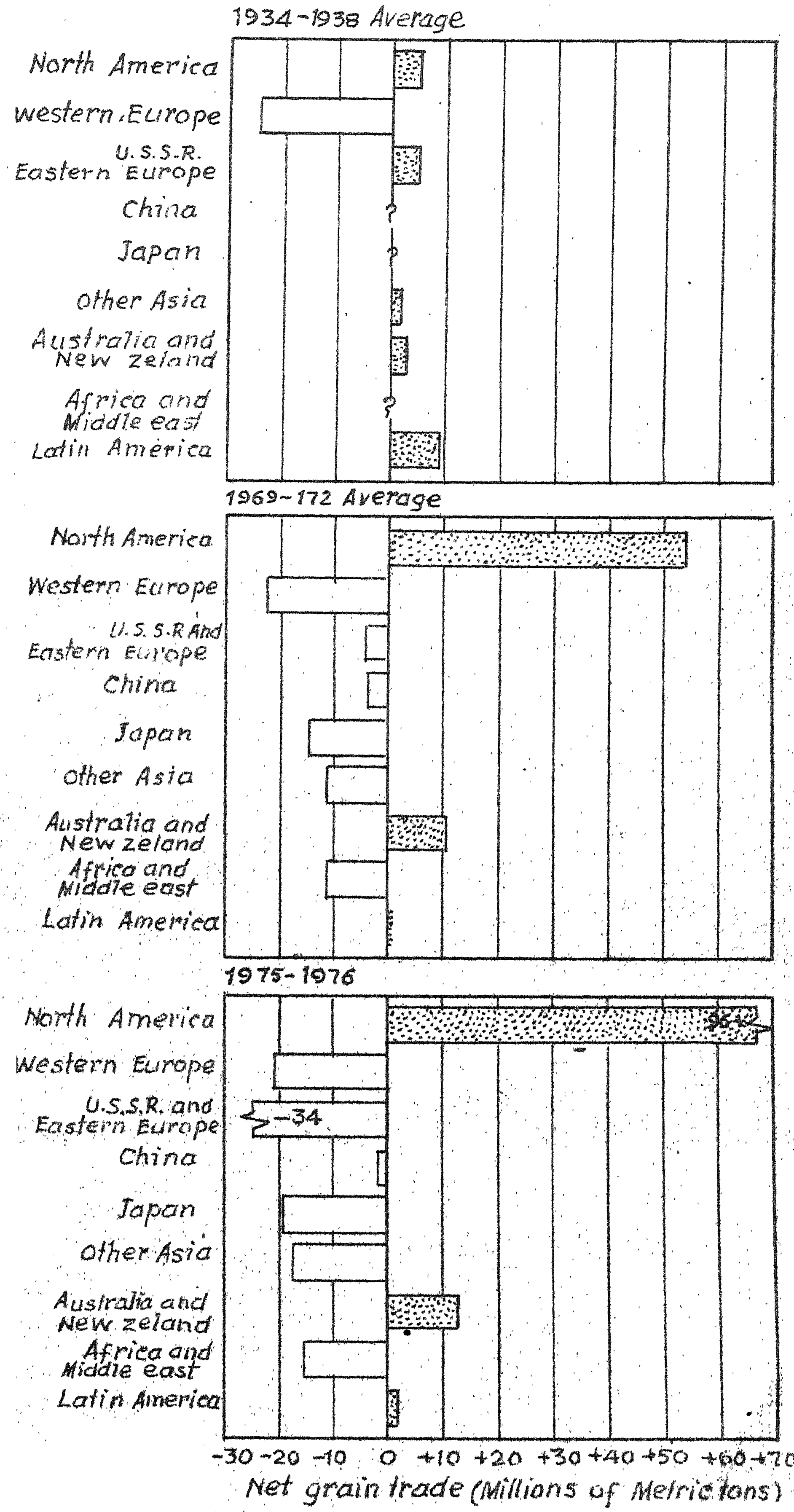

1934-1938 Average
North America
western Europe
U.S.S.R. Eastern Europe
China
Japan
other Asia
Australia and New zeland
Africa and Middle east
Latin America
1969-172 Average
North America
Western Europe
U.S.S.R And Eastern Europe
China
Japan
other Asia
Australia and New zeland
Africa and Middle east
Latin America
1975-1976
North America
96
Western Europe
U.S.S.R. and Eastern Europe
-34
China
Japan
other Asia
Australia and New zeland
Africa and Middle east
Latin America
-30 -20 -10 0 +10 +20 +30 +40 +50 +60 +70
Net grain trade (Millions of Metric tons)

FIG 1.1

II

Agricultural Policy in India

2.1 Agricultural policy in India is currently under heavy attack. We are bedeviled by the myth of a poor food performance arising from scandalous neglect of agricultural productivity and practically zero investment in the agricultural sector. The plans of the late fifties and early sixties placed much emphasis on heavy industry and fairly little on agriculture. It is quite true that we did not make single-minded commitment to the agricultural sector. But it is also true that at that time there was no assurance that heavy investment in this sector would pay off. Nevertheless, on the average we have had a fairly good record of growth and the increase in the production of foodgrains averaged 2.8 per cent per year from 1950 to the present, the rate which is significantly higher than the rate of growth of population of about 2.1 per cent in the same period. This should be seen in the context of the period prior to 1947 when food grain production virtually stagnated with an insignificant 0.1 per cent per annum growth rate compared to the population

of 1.51 per cent per year.

2.2 The growth of foodgrains production in the three decades, since 1950, can be divided into three periods; a period of accelerated growth based on traditional technology (1958-60), a period of transition(1960-65) and a period of increasing dependence on new technology with which we are involved at present.

2.3 In the first period, there was a significant growth. But it was clearly not due to any investment in modernisation. Fertiliser consumption admittedly grew at a very high rate but that was merely because the initial base was practically zero. The new crop varieties available did not increase yield but merely maintained yield in the face of disease such as wheat rust. Nor is there any reason to suppose that the organised Community Development Programmes had any immediate impact on agricultural production. Economists like Mellor have suggested that perhaps as much as one fifths of the production increase was due to extension of irrigation, another two-fifths to increase utilisation of labour and perhaps, third, to increase in the land under cultivation. It is

possible that the increase in the use of land/and labour arose from the abolition of the Zamindary system.

2.4 The transitional period was a record of the deterioration of the growth rate in foodgrains production to about 2 per cent per year. The population was at that time rising by 2.5 per cent per year and per capita income was rising at a higher rate than ever before due to an industrial growth rate of almost 10 per cent per year. This was also a period of increase in foreign aid from U.S.A. but such was the demand, that foodgrains prices rose very faster than the prices of other commodities. The disastrous droughts of 1965-67 went with a sharp deline in foreign aid and created a strong incentive for moving away from industrial situation to agriculture in general and the production of foodgrains in particular. Even in this period, however, the prime movers of growth in agricultural output were changing, moving away from traditional colonial technology to the new technology which was just becoming available from other countries bringing new lands under cultivation became less

significant than the use of fertilisers. Nearly 40 per cent of the increase in grain production in the period 1961-65 can be accounted for by the increased use of fertilisers compared to less than 10 per cent in the previous decades.

2.5 The technology with which this study is concerned became available to India about this time and it is worth setting out the factors responsible for the so-called Green Revolution in its initial stronghold - Mexico. Apart from the economic, social and political factors, the advances in foodgrains production were due largely to a combination of three technological factors; one, the development of new high yielding plant varities which were widely adaptable, responsive to fertilisers and resistent to disease; two, the development of an important "package" of agricultural practices including better land and water management, adequate fertilisation and more effective control of weed and insects which made it possible for the potential of the new plants referred to in (one) above, being the actual realised; third, a favourable ratio between the cost of fertilisers and other inputs and the prices received by the farmers for the product.

In the context of India, the third factor becomes the most significant one for the Green Revolution because, this is for the first time when the artificial low price of foodgrains becomes difficult to maintain. Food aid proved inadequate as the grain reserves were wiped out and the extent of shortfall could not be covered even though U.S.A. shipments to India were equal to almost 15 per cent of India's domestic production. It was not merely the rise in the price of foodgrains that changed the ratio but also the new commitment of self sufficiency in foodgrains which led to a concerted effort for this new technology. As we know the Green Revolution achieved its greatest success in Punjab and Haryana and indeed, Punjab showed a better rate of agricultural production than Taiwan, the much touted model of agricultural success. The first harvest after the drought (1968) showed record breaking gain in the production of foodgrains- 28 per cent in one year. Wheat production alone increased by 5 million tonnes and in the next 7 years it doubled with an average compound rate of growth of more than 10 per cent.

Figure and show the relative importance of different factors upon the Green Revolution.

2.6 The other two technological factors, viz. supply of High Yielding varieties and the package of agricultural practices, can also be seen at their best in Punjab which had an effective irrigation system and was provided with supply of reliable seeds from its excellent Agricultural University. The new-born State of Haryana, which was previously a part of Punjab, lagged behind to a large extent because of lack of assured irrigation in some areas and comparably fewer supporting institutions. In this context, the experience of rice is instructive. Of the three technological factors mentioned, the supply of suitable cultivars of rice was much more difficult perhaps than that of wheat. The High Yielding Varieties of rice were extremely susceptible to pests while the hardly local species tended to be immune. Equally there was great consumer resistence to the new rice. The farmers tended not to accept the package of agricultural practices because it entailed much higher risks because the areas in which rice was grown were, on the whole,

lacking in the structure of supporting institutions. Where these institutions were available, such as in Karnal in Haryana, the yield of rice did indeed rise though seeds used were traditional ones.

2.7 We find, therefore, that we can isolate four specific elements of successful agricultural development policy. First, the policy must keep the price of farm products relatively high and stable. It is for lack of this stability that in spite of short period of high food prices, for instance 1957-58 the farmers did not consider it worthwhile to product more. This would imply that there is a logic for ironing out the effect of our substantial, year to year, weather fluctuations by filling the gap not by import of grains but by the more costly method of domestic storage. In this way, the prices to the farmer remain stable and, though the cost to the consumer is higher than if we depended on imports, the long run advantages ought to be obvious.

2.8 The second element of successful policy relates to supply of major reserves like fertilisers and water. Not only must these be available

at the correct rate at any point of time but their prices should also be kept reasonably low. We have found that when the prices of fertilisers shot up as a result of the rise in price of petroleum, the consumption of fertilisers by farmers fell with equal sharpness. The subsequent action of the Government in lowering fertiliser prices has slowly increased the demand for fertiliser but it took at least two years for the consumption to recover. It is obvious therefore that the farmers are extremely sensitive to the prices of modern inputs. The experience with regard to seeds and water, however, has been less price-oriented possibly because these are two major inputs which reduce the farmers' risks of cultivation and therefore, are seen as absolute necessities. Nevertheless in the period in which the consumption of fertiliser fell sharply there was a tendency to grow traditional cultivars rather than High Yielding varieties. Consequently the requirement of irrigation water also fell.

2.9 The third element of successful agricultural policy is more difficult to implement. We must create a tenure system that affects the operating cost of

the farmers in a way that is favourable to innovation. A study of the tenural system in Haryana will show that it was possible to introduce the new technology only because the farmers were mostly owner operators. The sluggish introduction of new technology in share-cropping areas is self explanatory. If we cannot ensure the incentive to the farmers of minimising their cost, the whole rationale of increasing the productivitiy collapses.

2.10 Finally, we must encourage research and technology in the various aspects in the agricultural field and maintain adequate and continuous flow of information to farmers on the availability of new techniques. The investment we have made in training up scientists and extension workers in agriculture is possibly the single most important element of a successful policy.

2.11 The Report of the National Commission on Agriculture, 1976 goes into massive detail about the various aspects of our agricultural policy. In the context of our previous discussions, certain comments and recommendations contained in this report are of interest. The Commissioner's observations on various agricultural inputs point to the limitations in agricultural policy already stated.

2.11 With regard to seeds, it states that the Central Government took the initiative through the National Seeds Corporation 1963 to organise the production of high quality seeds and subsequent to the Central Seeds Act, 1966 it constituted a Central Seed Committee in September, 1968. The Central Variety Release Committee(CVRC) of the ICAR have been working between 1963 and 1970 for screening and releasing of new varieties of seeds for better use.

2.12 The limitations of the present policy have been noted as:

(1) the inadequacy of the total supply in the face of rising demand both spontaneously and under Government encouragement;

(2) the complex requirements of seed certification; and

(3) the somewhat erratic choice of farmers' fields for the trial of new varieties.

2.13 The new trend of policy is to concentrate seed production in large State Farms and owner permit certification of private farms if they are equally large and commercially oriented. The recommendation

of the Commission that farmers should be persuaded to join together for the production of high quality seed appears unrealistic even though seed production is highly profitable. The amount of organisation and technical expertise require for maintenance of appropriate larger production and maintenance of parent line is well beyond capacity of the average farmer. One of the reasons why drawrf wheat rather than hybrids have become popular is because this can be used by the farmer from season to season whereas hybrid seeds must be obtained from outside every year. However, the emphasis laid upon the Central Seed Committee and the I.C.A.R. to combine and evolve the machinery to tackle the problems of supply of high quality seed is an important step in the right direction. More limitations of which one is usually unware is focussed upon by the Commission - in particular the problem of transport. They have pointed out that the transport of seeds must be carried out with great speed and under appropriate insulation from the weather. In spite of these recommendation we still find seeds sent by railway wagons waiting in the siding open to heat and moisture, while the priority is given to industrial goods movement.

With regard to the quantities involved for multiplication of seeds the estimates of seed area and production for 2000 A.D. are given as 2010.09 thousand hectares and 2770.56 thousand hectares tonnes respectively.

2.14 Their comments with regard to fertiliser are based on the obvious fact that per capita arable land is low in India and likely to become lower. From the figure of 0.28 hectares per capita land in 1970-71 according to the projected date it outlined that is likely to be about 0.22 hectares in 1985 and about 0.17 hectares in 2000 A.D. of course, India is not, particularly, in an unfavourable position, if we consider the international situation. The per capita arable land in Japan (0.05 hectares), U.A.R. (0.09 ha.), U.K. (0.13 ha) and Belgium (0.09 ha) is much worse and the position of France (0.38 ha) is not much better. However, we do note that the demand for land for other than agriculture is also growing very fast so that technology must take recourse to multiple cropping and consequently much higher inputs of fertiliser. The policy suggestions may emphasise the constraints imposed by lack of adequate supply of fertilisers and water noting

that irrigation facilities are at present available to roughly 20 per cent of the cultivated area. The world fertiliser production trend is also shown as a matter of concern and the precariousness of the situation can be seen from the fact that 10 to 15 per cent compound rate of growth of consumption required by developing countries as a whole will be matched with surplus of only 5 per cent in the world market. The recommendation for increasing the domestic production of fertiliser have been followed by the Government of India to a very large extent. However, we should remember that the supply of feed stock for production, viz. natural gas, Naphtha and fuel oil is running out and coal is a much more expensive proposition. To put matters into perspective the manufacture of 44 million tonnes of nitrogen which the farmers consumed in 1976 equalled almost 1 million B/D oil equivalent in the form of feed stocks and fuel or less than 1 per cent of the total capital energy demand of that year. The amount of gas being flared in the Middle East alone would have been more than sufficient to fix that much nitrogen. If we can pursue the countries like Iran to upgrade a good deal more of its natural gas into higher value products like anhydrous ammonia

the availability of fertilisers need not pose any problems.

2.15 The production is not the only aspect of fertiliser policy. One important feature of the present strategy is to distribute the available supply as efficiently as possible. This problem is the responsibility of the Fertiliser Corporation of India, a Government of India undertaking. Their organisational set up, at present, is as follows:

(1) Fertiliser promotion and agronomic services;

(2) Sales and distribution;

(3) After sales service and market research

2.14 As to fertiliser promotion and agronomic services, a team of agricultural graduates, stationed in rural areas, who try to keep the farmers informed about the latest developments not only in the use of fertilisers but the use of complete package of agronomic practices.

2.17 Relating to sales and distribution, the policy of the Corporation is to distribute fertilisers through Cooperatives and through small private

dealers, 50 per cent of production in each case. They also have a scheme of training unemployed graduates and disabled army personnel ultimately to appoint them as their own dealers. The distribution of fertiliser is made from the factory by railway or road, and in the peak season from fields as well buffer godowns. In Haryana, with which the study is concerned, the area office is located at Karnal and three Sales Officers at Rohtak, Hissar and Kurukshetra Co-ordinating sales at block and mandi levels. This system often results in payment of sales tax twice over, when the factory is in a different State.

2.18 After sale service and market research includes a system of inspection of dealers'godowns for analysis of the quality supplied. It also collects data on farmers reactions to the use of fertilisers and other inputs.

2.19 The overall shortage, however, is reflected in the fact that they are only able to satisfy the requirement of the State to the extent of 30 per cent and even with the opening of the new Urea Plant at Nangal only 60 per cent to 70 per cent at the maximum of the demand will be satisfied.

2.20 The important aspect of fertiliser distribution policy is the legislation under the Essential Commodities Act and the Fertiliser Control Order, the broad objects of which are to ensure that the farmer gets the right kind of material at the right time and at the right price. The various provisions of the Fertiliser Control order seek to attain the following:

(1) Regulation of quality,

(2) Regulation of trade,

(3) Regulation of price, and

(4) Regulation of distribution.

2.21 From the policy point of view, probably the most unsatisfactory part of the order is that relating to price control. Since prices in the international market have shown enormous fluctuations, of course, farm input price control is a natural corollary to the control of foodgrain prices. In the case of fertiliser it is particularly important since as pointed out by the Agricultural Prices Commission, next to labour fertiliser is the biggest component of operational expenses. In the case of irrigated wheat and paddy, discussed in the

present study, almost 28 per cent of the operational expenses of cultivation are accounted for by fertilisers. If the present Fertiliser(Movement) Control Order is streamlined and the deficit of indigenous fertiliser in any area is met by the stocks of fertiliser in the Central Pool, the prices will be stabilised all over the country. The co-ordinated supply plan, however, has not been very rationally determined as noted elsewhere in this study. We have shown, in detail, the recent improvement in distribution policy, the full effects of which can only be felt next year, when the impact of new formula for fertiliser distribution will be complete.

Table 2.1

Area under best Rabi Season (Rabi 1976-77) consumption in best Rabi 1976-77.

Area in '000' hectares	N	P	K	Total
	79264	12659	4883	96806

Rabi 1976	HYV	NON HYV		TOTAL
1. Wheat	1208	150.0		1358
2. Gram	-	1065		1065
3. Barley	-	95		95
4. Rabi Pulses	-	38.7		38.7
5. Rabi Oil Seeds	-	107.5		107.5
6. Fruits & Vegetable	-	42.1		42.1
7. Others	-	323.0		323.0
	1208	1821.3		3029.3

Standard Area: $1208 \times 1 + 150 \times \frac{1}{2} + 1065 \frac{1}{2} + 95 \times 2/5$
$38.7 \times \frac{1}{4} + 107.5 \times \frac{1}{2} + 42.1 \times 5/4 + 323 \times \frac{1}{4}$
$= 1757.3$

	N	P	K	Total
Av. Dose(Kgs./Hect.)	45.1	7.2	2.7	
Av. Dose for Rabi 77-78 as worked out at 13% compound increase over 1976-77.	51	8	3	62

AREA UNDER RABI 1977-78 IN '000' HECT.

Crop	H.Y.V.	Non H.Y.V.		Total
1. Wheat	1100	150		1250
2. Gram	-	1075		1075
3. Barley	-	150		150
4. Rabi pulses	-	55		55
5. Oil Seeds	-	175		175
6. Fruits & Veg.	-	44.9		44.9
7. Other Crops	-	340		340
Total :-	1100	1989.9		3089.9

Table 2.1 Cont.

Standard Area for Rabi 1977-78 in '000' Hect.

1. Wheat HYV	1100X 1	=	1100.00
2. Wheat Local	150X ½	=	75.00
3. Gram	1075X ¼	=	268.75
4. Rabi Pulses	55X ¼	=	13.75
5. Rabi Oil Seeds	175X ¼	=	43.75
6. Fruits & Veg.	44.9X ½	=	56.10
7. Other Crops	340X ¼	=	85.00
8. Barley	150X 2/5	=	60.00
	Total	=	1702.35

Requirements for Rabi 1977-78 (In Tonnes)

N	P	K
86819.85	13613.8	51070.05

	N	P	K	Total
1. Consumption in best Rabi 1976-77.	79264	12659	4883	96806
2. Best Rabi Cons.in each Nutrient.	79264	12659	4883	96806
3. Consn.in Rabi 76-77.	79264	12659	4883	96806
4. Requirement as finalised for Rabi 76-77.	81000	12000	4000	97000
5. Requirement as asked for Rabi 1977-78.	90000	20000	10000	120000
6. Requirement on the basis of formula.	86819.85	13613.8	5107	105544.85
7. Require.30% above best consumption of each nutrients.	103043.20	16456.70	6347.90	125847.80
1. Targets proposed for Rabi 1977-78.	90000	20000	10000	120000
2. 10% in Pipeline	99000	22000	11000	132000
3. Net requirement after reducing estimated stock as on 31.7.77.	96362	21510	10869	128741

Table 2.2.

STATEMENT SHOWING THE FERTILIZER CONSUMPTION IN THE STATE SINCE THE FORMATION OF HAU

(NUTRIENT IN TONNES)

YEAR	KHARIF				RABI				TOTAL			
	N	P	K	Total	N	P	K	Total	N	P	K	Total
1966-67	4984	178	30	5192	7642	396	117	8155	12626	574	147	13347
1967-68	12107	632	163	12902	18120	1094	359	19573	30227	1726	521	32474
1968-69	14402	687	166	15255	25923	4826	1020	31769	41325	5513	1186	47024
1969-70	13572	1129	365	15066	33428	3991	1435	38854	47000	5120	1800	53920
1970-71	19200	1041	297	20538	41772	5819	1931	49522	60972	6860	2228	70060
1971-72	22081	962	499	23542	51351	5343	1898	58592	73432	6305	2397	82134
1972-73	30145	1704	490	32390	52961	6471	2121	61553	83106	8175	2611	93892
1973-74	39330	6560	2290	48180	54730	9913	2174	66817	94060	16473	4464	114997
1974-75	22902	2724	831	26457	43179	4393	1448	49020	66081	7117	2279	75477
1975-76	23368	992	386	24746	62940	7330	1899	72169	86308	8322	2285	96915
1976-77	36239	3002	1098	40339	79264	12659	4883	96806	115503	15661	5981	137145
1977-78	49079	4729	1606	55414	101116	23925	7656	132697	150195	28654	9262	188111
					(1977-78) Target -				144000	28000	13000	185000

Target for Rabi 1977-78

N	114000
P	24000
K	12000
Total	150000

Fixation of Fertiliser Targets

2.22 The Government of India has evolved a formula for determining the fertiliser requirements of different States in India. This is a welcome change from the system that used to obtain before 1977-78 and very much better than the total ad hoc allocations of a decade ago. In the past, the allocation of fertiliser targets to different districts was done on the basis of best performance. Using best performance as an index , a flat across-the-board increase was decided upon. For instance, in a particular year, this growth rate could be set at 13 per cent, say, for all districts. As long as the total amount of fertiliser used was very small, this kind of ad hocism did not do very much harm. It is obvious, however, that there is no reason why the initial use of fertilisers by districts would bestrictly proportional to their technological optimum. The result was that quite often the ability of a district to use its fertiliser target was either lower or higher than the target fixed. When we consider the high prices of Petrolium and Naphtha which are feed stocks for fertilisers, the un-economic nature of such calculations becomes disturbing.

2.23 According to the present formula, the area under different crops and their varieties is converted into standard acreage. For this purpose, the best performance season is used. The standard acreage is divided by the consumption of N,P and K during the best consumption year to determine the level of fertiliser used which has been attained in the best consumption season. An example will make this clear. Suppose that we are dealing with three consecutive years, say, A, B & C and the consumption of fertilisers N,P & K are shown in the Table below:

Year	Fertilisers kg. N	P	K
A	70,000	12,000	4,000
B	65,000	13,000	4,500
C	68,000	10,000	4,800

In this case, the formula for the best consumption years will be N = 70,000, P = 13,000 and K = 4,800. This will then be used as the basis

of the best consumption season.

2.24 Actual acreage is converted into standard acreage by determining the dose of fertiliser appropriate to the crop grown on that acreage. For instance, if we consider the demand for fertiliser per hectare of HYV wheat to be the unit of calculation i.e. as one, the requirements of fertiliser in Gram will be ¼, one quarter; then the acreage on which the Gram is grown will be divided by 4 to convert into standard acreage.

2.25 Once we know the standard acreage and the fertiliser use level attained in the best consumption season, the average dose for the crop season can be worked out. During 1977-78 the targets for all the districts were worked out according to this formula though some minor adjustments were made keeping in view the best performance and rate of growth. The flat-rate compound increase of 13 per cent was then applied in keeping with the general policy of increase in the use of fertiliser, as a whole. The position for Haryana is shown in the Tables below, 2.1 + 2.1 Cont.

It is claimed that as a result of this exercise, it was possible to fix a very realistic target. There is some justification for the new formula, as is borne out by the fact that in almost all the districts, the targets set out were less than or slightly exceeded. In 1977-78 in Haryana, against the target set out at 1,85,000 tonnes of N,P & K the achievement was 1,88,000 tonnes. It should be noted, however, that as Table shows, consumption of fertiliser has always been fairly high in Haryana, so that the previous formula also did not result in unutilised fertiliser.

2.26 The third important aspect of policy focussed on by the National Commission is unfortunately the most intractable one and that is the question of power. The experience of all countries has been that there is definite and positive relation between farm power availability and farm productivity. We have been depending mainly on bullock-power for farm operations but more progressive farmers are now using machine-power as well. Average farm power availability in the country from all sources, according to the Commission was 0.36 HP per hectare in 1971 of which over 62 per cent was

contributed by human labour and draft animals. Of the remaining 38 per cent, the share of tractors was just about 4 per cent while the pumps sets had a much larger share of 32 per cent. Of the total number of 317 districts considered only 20 had power availability of 0.80 HP per hectare or more, most of them are in Punjab and Haryana. A well-known report by the President's Science Advisory Committee(1967) concluded that the power range for satisfactory yields should lie between 0.5 and 0.8 HP per hectare. But the problem of timeliness of seed-bed preparation is not mentioned there. Our problem in India is precisely that even in those areas in which power is available; it arrives too late for agricultural activities. The Commission comes into terms with this by pointing out that the bullocks are going to be maintained at the existing level even in 2000 A.D. It's recommendations, therefore, are mainly for the purpose of improvement of their breed and health. They also considered that selective mechanisation will be essential. In other words, a relation of complementarity is sought to be maintained between bullocks and mechanical/electrical power.

2.27 The present policy of the Government of India is tailored to the production of traditional implements and bullock-carts of better design and material as well as the production of tractors and their accessories. The idea that the present capacity for the production of tractor is not adequate is one of the paradoxes of our policy. A great deal of lip service is paid to the necessity for standard quality implements and more efficient bullock carts. The Commission identifies traditional implements which should get priority in design as follows:

" The following are vital considerations in developing new tools and implements and improving those already in use:

(1) adapt tools for more efficient performance and speed work;

(2) minimise fatigue by improved balance and work position;

(3) reduce injury or wear to man or animal;

(4) keep weight low for easy transport;

(5) construct from local readily available materials;

(6) choose the most simple design appropriate to the type;

(7) design for specific tasks and with only simply adjustments;

(8) require loss maintenance and preparation for use;"

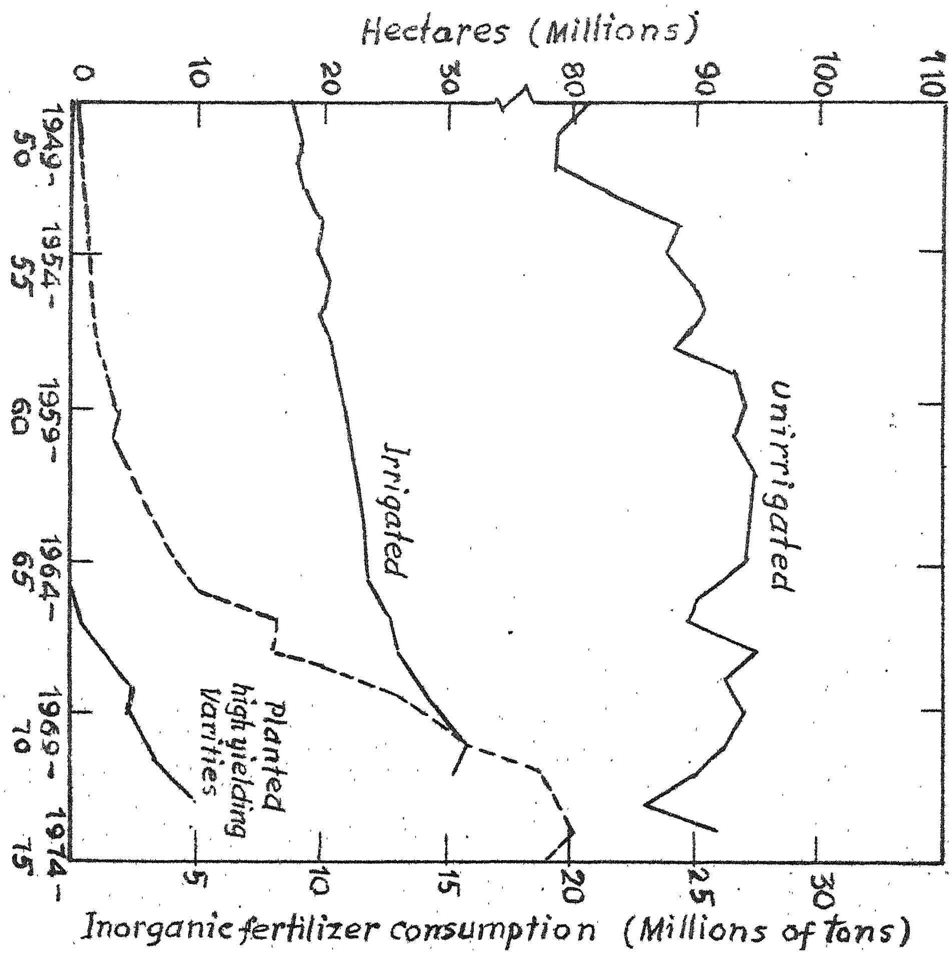
and so on .....

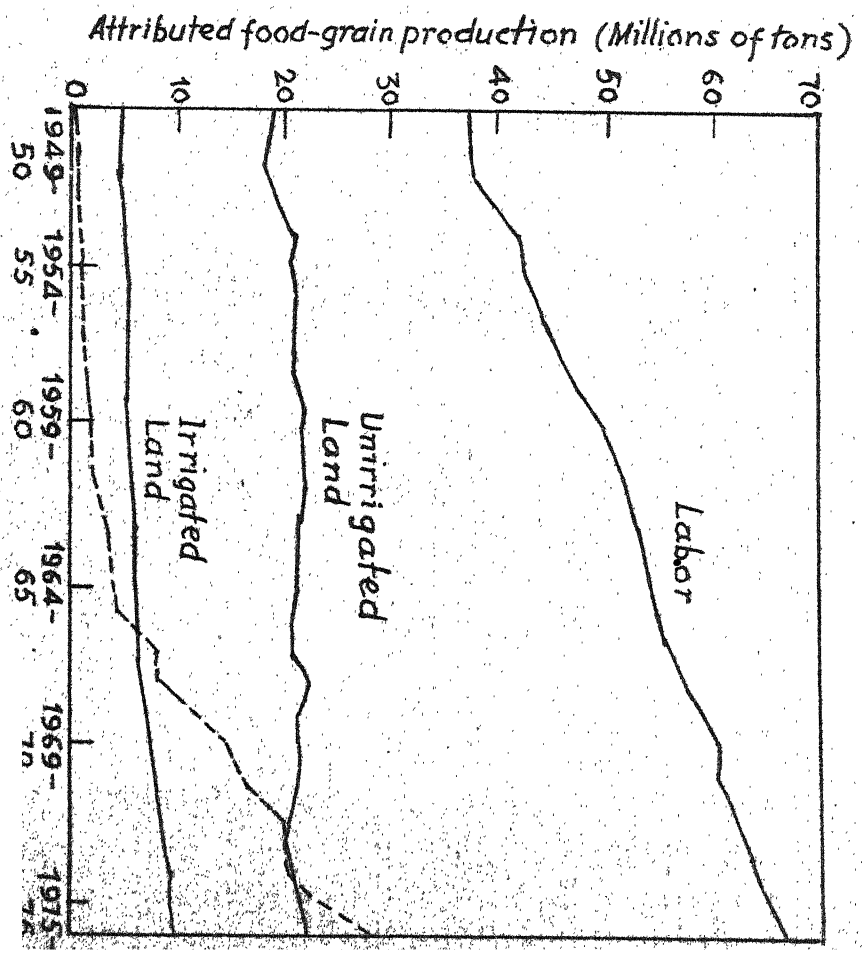
2.28 The performance, however, belies the promise; for example, the request (properly funded) by the Government of Haryana to the Agricultural University, Hissar, to produce the prototype of a better bullock-cart has been quietly ignored for the last two years. In this context, the recommendation of Commission on production of tractors and other machinery becomes more important. The establishment of RTTC(Regional Research Testing and Training Centres) specially under the auspices of Agricultural Universities and the encouragement for custom tractor stations seem hopeful.

2.29 In conclusion, what is the impact of the present agricultural policy on the farmer ? It is not true that the Indian farmer is risk averse. However, he is much more vulnerable; his ability, that is to say to take financial shocks is much greater then that of farmers of developed countries. 80 per cent of

farm families fell under the indigent category. Further, the nature of risk facing the farmer appears to be more pervasive, indeterminate and unensurable, the results of failure would be in fact be calamitous. His control of farming conditions and operations is comparatively low with the limited irrigation facilities and inputs available. To the farmer modern farming is a new technology. Many more inputs in critical and delicate plants are required and the operation steps and supervisions are sophisticated and time-consuming. Co-ordination of services and inputs is imperfect and because of this timely availability is not always to be found. Modern farming organisation is still over-centralised. Seeds must come from State Farms; irrigation is is controlled from a distance and services are a part of the bureaucratic system, their stability is undependable. Psychologically the farmer reacts like a patient in an outdoor dispensary, served from the standard bottles. Unlike in industry, the problems in farming cannot be standarised; information flow from top to bottom must be tailored to individual cases. The scope for rural administration at the gross roots level has still not been

exploited. Nevertheless even the cropping and input package standardised at the district level is an improvement on leaving the farmer entirely in the dark. Faced with near impossible problem of size and complexity, the present policies are a step in the right direction.


Hectares (Millions)
0
10
20
30
80
90
100
110
Unirrigated
Irrigated
Planted high yielding Varities
1949-50
1954-55
1959-60
1964-65
1969-70
1974-75
5
10
15
20
25
30
Inorganic fertilizer consumption (Millions of tons)


Attributed food-grain production (Millions of tons)
0
10
20
30
40
50
60
70
Labor
Unirrigated Land
Irrigated Land
1949-50
1954-55
1959-60
1964-65
1969-

III

Materials and Methods

3.1 This study is based on two types of published data, those on fertiliser response and those on price and production data. For the response of various crops notably rice and wheat to N, P & K the sources have been the experiments, including field experiments, carried out by the Haryana Agricultural University, Hissar, Indian Council of Agricultural Research and the Department of Agriculture, Government of Haryana. Particular attention has been paid to studies on the response to fertilisers of different cultivars of rice and wheat commonly grown in Haryana, for which the experiments on farmers' fields have been replicated over a number of seasons/years.

3.2 Effort was made to check the reliability of the data with actual field conditions by series of structured interviews with farmers in the Ambala, Karnal and Kurukshetra region over a period of four consecutive years i.e. 1971-75 and in Gurgaon and Rohtak for two Rabi and one kharif seasons in 1974 and 1975. The list of villages visited is appended at the end of the chapter.

3.3 Cost of inputs and harvest price of grain has been obtained from the Annual Statistical Abstracts issued by the Planning Department and the Government of Haryana and checked against the studies in the"Economics of Farming in Haryana series" as well as the Government of India, Department of Agriculture figures of farm harvest prices. In the interviews, referred to in the foregoing paragraphs, an effort was made to confirm these figures from farmers agricultural labourers and Patwaris.

3.4 The cropping pattern and the agro-economic practices assumed in the study have been kept as close to actual farm practices as possible. However, since the response to the agricultural extension workers has been quite good and since the objective was to work out the optimum return, the package of practices recommended by the Department of Agriculture, Government of Haryana have used for cost calculations.

3.5 While no attempt was made to set up special field trials, the reliability of the secondary data has been increased because of the extensive interviews conducted in over 1 per cent of the three

districts above noted and another 0.5 per cent of the two other districts. The selection of farmers to be interviewed was made partly on the basis of availability of irrigation on their land(i.e. all the farmers were owner-operators of irrigated land) partly on the basis of their distance from trading centres. About two-third of the farmers were quite close to big mundis and the rest were connected to the markets by metalled roads. It is possible, therefore, that the figures for casual and permanent labour are more stable and slightly higher than the average for the rest of Haryana. The harvest prices are also likely to be slightly higher. Attempts were made to interview small and marginal farmers but it was difficult to obtain any kind of reliable data from them as they tend not to keep accounts. Nevertheless, they were able to say something about the immediate past cropping season.

3.6 It is necessary to give some details about the interviews with farmers mentioned above. Initially, an attempt was made to use questionnaires. But a number of difficulties arose. Most of the farmers did not keep detailed accounts. Perhaps they were reluctant to disclose their costs and income. Farmers who had

kept accounts and were willing to part with the information were mainly those who were already paid to do so by the Government of Haryana under a scheme of collecting data for reports on "Economics of Farming in Haryana." Consequently, no new information was forthcoming. In a number of cases, farmers categorically stated that they would not answer questions which might be used as basis for tax assessment. Questionnaires also tended to narrow down the informative data into purely quantitative dimensions. Consequently questionnaires had to be discarded and an interview method substituted.

The interviews were however, carefully structured.

In the interviews the questions asked were about:

1) Choice of crops grown on individual farms as well as neighbouring farms and changes in cropping pattern in recent times.

2) The availability and prices of inputs like water, seed, and fertilizer.

3) The extent to which H.Y.V. seeds are preferred and the corresponding increase in water, fertilizer and labour inputs.

4) The price of output at the Mandis at harvest time and the maximum price available (what was the impact of the procurement price fixed by the Government ?).

5) The labour situation and the different seasonal demand for labour.

6) Mechanisation- i) how many used tractors, ii) what are the small modern implements used, iii) how many actually own or hire tractors and implements used ?

3.7 The interviews practically repeated various portions of the previously attempted questionnaire but were more free-ranging. Often it was possible to get the adult members of the family together for this discussions. As a result new points were raised and corrections were made, often by the women, who would otherwise not have given any information, as questionnaires are typically filled up by menfolk and indeed by the few of them who are literate. As an instance, a point came up abóut the procurement price and one of the women present complained that routinely the inspectors refuse to buy wheat at the procurement price ostensibly because it was not of standard quality. The men, probably, intimidated by

by thoughts of official reprisals hastened to add that they did not have modern threshing, drying and storage for foodgrains and consequently the objections raised by the inspectors were often justified. From this discussion, an important policy programme emerged, the necessity for providing proper joint facilities for grain preparation at harvest time. If the poorest farmers are to get their due, this kind of information was unlikely be available from questionnaires. Group discussions with Panchayat members and junior Government officials like Extension Officers, and Patwaris also provided supplementary information. The main focus of group discussion was the availability and timings of water and H.Y.V. of seed. Panchayat members on the whole felt that there was a great deal of unsatisfied demand for H.Y.V. seeds and that the distribution was arbitrary with regard to water. There seemed to be a consensus that there is never as much water available in each season as the official records show, with the result that the people at the tail end of a canal very often do not get irrigation water at all. Here again questionnaires would not have elicited this kind of information. Many farmers, in fact, if they are at the tail end of a canal, sell their right to get the water to someone further up the canal and

since this is a source of profit, they would have almost certainly concealed the information in the questionnaires. Extension Officers who were frequently vocal.... about their efforts to get their supply of fertilizer and seed in time for sowing would have been much less forthcoming in a questionnaire, however, anonymous or confidential.

3.8 It is quite likely that talking freely as they did in interviews, farmers, agricultural labourers and Government servants may have exaggerated their difficulties but on the other hand a lot of comparatively unquantified or even vague statements do have important policy implications.

3.9 The exercise carried out here is largely illustrative and therefore, slight variation in costs and value of output should not vitiate the result so obtained. It is most important to get into the farmers mind and see how we can reconcile our two objectives, i.e. maximise his income and our social benefit.

3.10 For the graphical presentation of the different techniques of production with varying capital intensities, the format is that of a "production locus" used by Professor Gautam Mathur in his book: Planning for Steady Growth(Basil Blackwell, Oxford 1965). The

reason for choosing this format, as opposed to the more common "production function" is that the latter is based on a given wage rate, whereas the former is able to accomodate different wage rates for different techniques. Even the concept of the production locus was not found totally suitable and had to be adapted. The change and the reasons for it are given more explicitly later on in this study, in the chapter dealing with choice of techniques.

3.11 In conclusion we should be clear about our objectives in this study. This will determine our methodology. If we want to list and describe the factors responsible for changes in the yield of, say, what on irrigated land, the answer is intimidating, almost horrifying. Let us set out some of the output affecting factors. They are not wholly quantified and, therefore, the output or production function is obviously not feasible. If we define such a function as a set of equations which relate the output of a commodity(in this case wheat) to all the factors that systematically affect that output within the specified context(in this case the estimate of irrigated land in Haryana) then we can talk of soil, rainfall, soil temperature, light

humidity, water holding capacity, residue, fallow, seeds, tillage, planting times, cultivation methods, fertilisers besides, disease, weeds, water and wind. If we move into handling grain then, we have to add harvesting, drying, cleaning, marketing, merchandising and so on. As written here, this is over-poweringly complex but really to quantify it, it would not only be far more complex but, in all likelihood, the function would never be known precisely for long or perhaps ever. Even fertiliser alone can possibly be stated in hundreds of different variables.

3.12 There are other major measurements and analytical complexities. These determining variables are all dated. When you talk of planting, you are talking of times, seasons, constraints of planting and constraints of harvesting- a complex dated and temporal system. It is also a serial system, that is, the determining variables are inter-related. The importance in this case of changing such inter-relations were shown after the availability of changed varieties of seeds which gained some control over the fertiliser- water- output relationship. Thus we could and did negate some of these variables by changing their inter-relationship.

It is also a dynamic system, not a static or disjunctive equilibrium model. It involves a sequence of actions, in the sense that what you do on the first November determines dot merely what you should do on the 1st March but also what you can do. So, there is a casual relationship of over time amongst most of these determinants following this long run system. There are longterm limitations, if we out the source of soil and water conservation on the production of wheat. Its relevance or impact is over many years.

3.13 What can we do about the seemingly overwhelming complexities ? What this study is attempting to do is to concentrate on a simple target, not trying fully to analyse or control the function. Out of the massive complex of determinants we have tried to change the production-function by change of only two variables, namely, seed and fertiliser (and perhaps some water management). Of course, by choosing HYV seeds, we do change other determinants like disease response and timing of harvest but fundamentally, this is a programme of two variables only - change in the seed constituency and change in the fertiliser constituency. We have taken the rest essentially is given on a static basis- at farm

level. We want more wheat and rice at the market and the programme is oriented to get more yield on the farm and to allow the rest to take care of itself, and we want to ensure that the farmers choose a technique which is the social optimum. This study attempts to isolate the minimum number of crucial relationships which will lead to a rational policy framework.

Appendix to Chapter III

Villages used as centres from which to visit neighbouring areas for the purpose of interviewing farmers and others-

Village	District
Kaul	Kurukshetra
Butana	Sonepat
Ferozepur Namak	Gurgaon
Sidhnauli	Gurgaon
Khori	Mahendragarh
Dharsul Kalan	Hissar
Siswal	Hissar
Sisai	Hissar
Jhoju Kalan	Bhiwani
Khanik	Bhiwani
Shamlo Kalan	Jind
Mandhor	Ambala
Arjaheri	Karnal
Azadnagar	Rohtak

IV

Physical Environments of Agricultural Relevance and Cropping Pattern in Haryana.

4.1 The general slope of Haryana is from north east to south west and west with an exception in the south in Bhiwani, Mahendragarh and Gurgaon districts where the slope is towards north. The latter form of surface does not permit the extension of free-flow irrigation from the existing canal system and, therefore, this area has recently been given some lift irrigation schemes. The variable slope tendencies have resulted in saucer like depression in the eastern margin of Rohtak district. In about 68 per cent of the total area of Haryana the gradient is very gentle and is, therefore, fit for the extension of canal or tube-well irrigation. The gentle gradient also makes movement of surface water sluggish. Thus, during the monsoons soluble salts are washed down the soil profile and in the hot and dry season the salt solutions reach the surface by capillary action and crystallize as a white incrustation on the surface. Such incrustations are common in Rohtak, Sonepat, Karnal, some areas of

Kurukshetra and Jind district, the old irrigated parts of the State. Efforts are under way for reclamation of the "Kallar" (nearly 4.5 lakhs hectares and 8,000 hectares of such land have already been reclaimed by Gypsum treatment.

SOIL

4.2 Soil surveys and investigations by the Haryana Agricultural University, Hissar, has made it possible to prepare extensive soil maps for Haryana in the last few years.

4.3 From an agricultural stand-point, it is significant to recognise the large region comprising flood plains (Khaddar or Bet and Naili), aluvial plain (Bhangar or Nardak or Chhachhra) and sandy undulating plain. Of the total area of the State, about 68 per cent, designated as the Ghaggar-Yamuna plain comprise Bhangar, Khaddar, Naili and Bet; 25.55 per cent lying in the district of Bhiwani, Mahendragarh and north western extreme of Gurgaon is covered by sand dunes. 1.6 per cent in the north east in Ambala district at the foot of the Siwaliks can be designated as the piedmount

plain, 3.09 per cent in the south in Mahendragarh, Bhiwani and Gurgaon lies in the form of rocky surfaces. Thus, uncultivable hills or rocky surfaces are insignificant, i.e. only about 2.06 per cent.

4.4 In most part of the State the soil is deficient in Nitrogen and the problem of salinity/alkalinity is pretty alarming in addition to soil erosion which occurs on account of wind and water. District Karnal suffers from water logging due to the non-availability of proper natural drainage and inadequacy of water management practices.

4.5 Soil acidity is no problem in Haryana because pH value is over 5.6 every where. In fact, there are no acid soils in the State. The State is, however, facing acute problems of salinity and alkalinity.

4.6 The soil fertility status including the Nitrogen, Phosphorus and Zinc status are shown in the maps at the end of the chapter.

CLIMATE

4.7 The most characteristic features of the climate of Haryana are found in meagreness, concentration, variability and unreliability of rainfall. The climatic condition ranges from sub humid to arid. On the whole, the climate of Haryana can be classed as a Sub-Tropical Continental Monsoon climate possessing the following characteristics:

(a) seasonal rhythm,
(b) hot summer
(c) cool winter
(d) mostly dry except for two to three months(July to September)
(e) meagre aberrant rainfall,
(f) unreliable rainfall, and
(g) wide variations in temperature around the annual mean.

4.8 There are two main cropping seasons, viz. kharif(summer) and rabi(winter) though there is "Zaid" (additional) cropping, known as kharif zaid and rabi zaid as the case may be.

4.9 Pattern of annual total of rainfalls show marked spatial differences varying between 100 mm. on the Siwaliks and less than 300 mm. along the south western borders of the State. Individual yearly conditions vary considerably from the mean values, between 25 and 45 per cent. A rainfall map of Haryana is appended at the end of this chapter.

4.10 The average annual water deficit decreases from a little more than 110 cm. in the west to a little less than 50 cms. in the north east. It occurs in two distinct phases, pre monsoon (March to June) and post monsoon (October and November) seasons.

IRRIGATION

4.11 The net irrigated area of Haryana has been increasing very rapidly(Table Figure and 4.1). The main source of irrigation is through canals which command about 70 per cent of total irrigated area and this is expected to increase substantially. Now that Beas Sutlej Link Project has been nearly completed and the various Lift Irrigation Schemes including Jawaharlal Nehru Canal are well under way,

there will be additional sources of perennial irrigation. Recently efforts have been made to exploit sub-soil water through minor irrigation schemes, but wells and tube-wells capture only about 20 to 25 per cent of the net irrigated area. It is also notable that there is an enormous difference in the cost of canal and well irrigation particularly since the cost of canal irrigation is almost entirely done by the public sector and water rates are very low. Moreover, the ground water resources are said to be meagre though they have never been surveyed very systematically. However, due to uncertainties of canal water, wells and tube-wells using diesel/electric pumps have become popular in Karnal, Kurukshetra and Ambala district which practise double cropping and commercially organised. The distribution of irrigation by source, i.e. canal, well etc. is shown in Fig. 4.1 at the end of this chapter.

Cropping Pattern

4.12 Since its formation in 1967, 82.8 per cent of the population of Haryana depended on agriculture and 92 per cent of the land available for cultivation was actually under plough. The State occupied the second position in the per capita production of food grains with 289.1 kgs. which was second only to Punjab with 319 kg. The area sown more than once has also shown a steady rise from 731 thousand hectares in 1965-66(which was slightly more than one-fifth of the net area sown) to 1585 thousand hectares in 1973-74 which was about 42 per cent of the net area sown. Due to urbanisation the land available for cultivation has gone down so that the net area sown has increased only marginally upto 1969-70 and has remained static thereafter. The percentage of the total area sown has remained high at about 80 to 81 per cent.

4.13 The production of the principal crops has changed both quantitatively and in emphasis. In 1967-68 the important grains were the so-called inferior grains like Bajra, Barley and Maize. In fact, in 1950-51, the production was 330 thousand tonnes

of Bajra compared to 294 thousand tonnes of wheat. With the availability of water and high yielding varieties of seed, wheat has now become clearly the most important food crop though improved varieties of Bajra are available and its yield has increased. As an illustration in 1971-72, 2402 thousand tonnes of wheat were produced as against 624 thousand tonnes of Bajra.

4.14 On the other hand, rice has become an important crop. The production was a mere 43 thousand tonnes in 1950-51 but in 1971-72 it was 536 thousand tonnes. The picture is even clearer when we note that the area under low priced crops has gone down sharply. The importance of Gram has likewise gone down while that of oil seeds and other pulses has gone up sharply. For instance, where 36,000 tonnes of oil seeds were produced in 1950-51, in 1971-72 the figure was 98.6 thousand tonnes. Sugar-cane which requires a great deal of water and cotton, both "American and Deshi" also show a very sharp rise, the most spectacular growth being that of American cotton which grew up by a factor of 4 between 1955 and 1973.

4.15 The main Rice growing areas in the State are Karnal and Kurukshetra while the wheat growing areas are more evenly spread out. There is a typical rice wheat rotation in Karnal and Kurukshetra though areas of Hissar with perennial irrigation and of Ambala with assured rainfall also used a wheat rice rotation. Cotton is almost wholly located in Hissar and Sirsa districts and is grown as a kharif crop and is rotated with wheat as a rabi crop. Where water is not available the land is sometimes left fallow in the rabi season or gram or fodder crops like Berseem, are grown.

4.16 The study of farm economy has shown an increase in the dependence on chemical fertilisers. The consumption has increased very sharply However, field trials show that the use of fertilisers is still not optimal. The farmers face two problems. Firstly, by and large, the doses of fertilisers employed are too low and secondly the concept of balanced fertiliser is not understood. We find that most of the farmers use only nitrogenous fertilisers and the use of complex or mixed fertilisers is practically unknown except for a few large commercial farms. There has been some

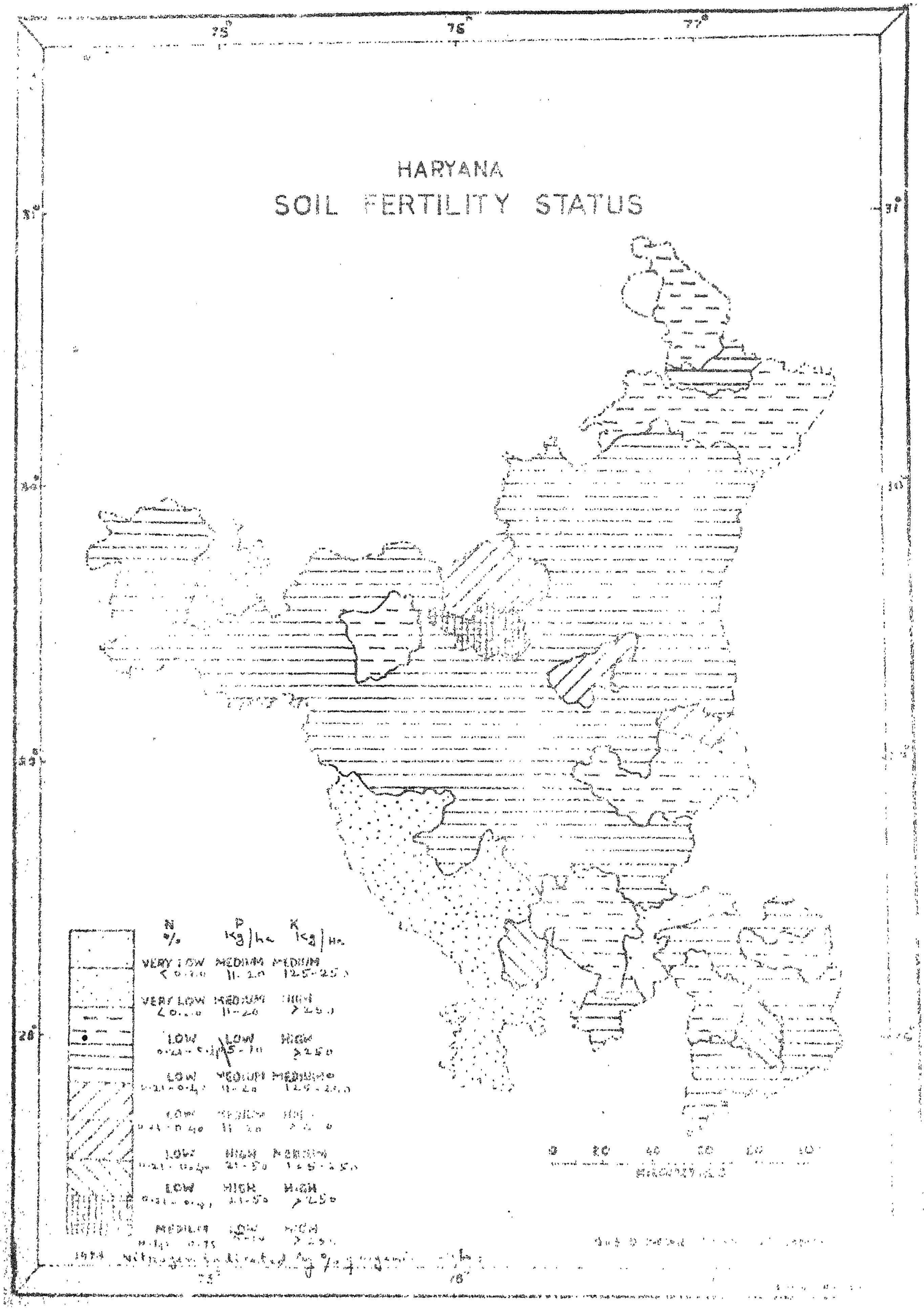
attempt lately in educating the farmers through the Extension Services of the Haryana Agricultural University(Hissar) and Agricultural Extension workers of Government in the field both with regard to soil and water management and crop rotation. On the whole, the farmer at present confines his use of fertiliser entirely to irrigated land. The use of fertilisers with dry farming practice is negligible.

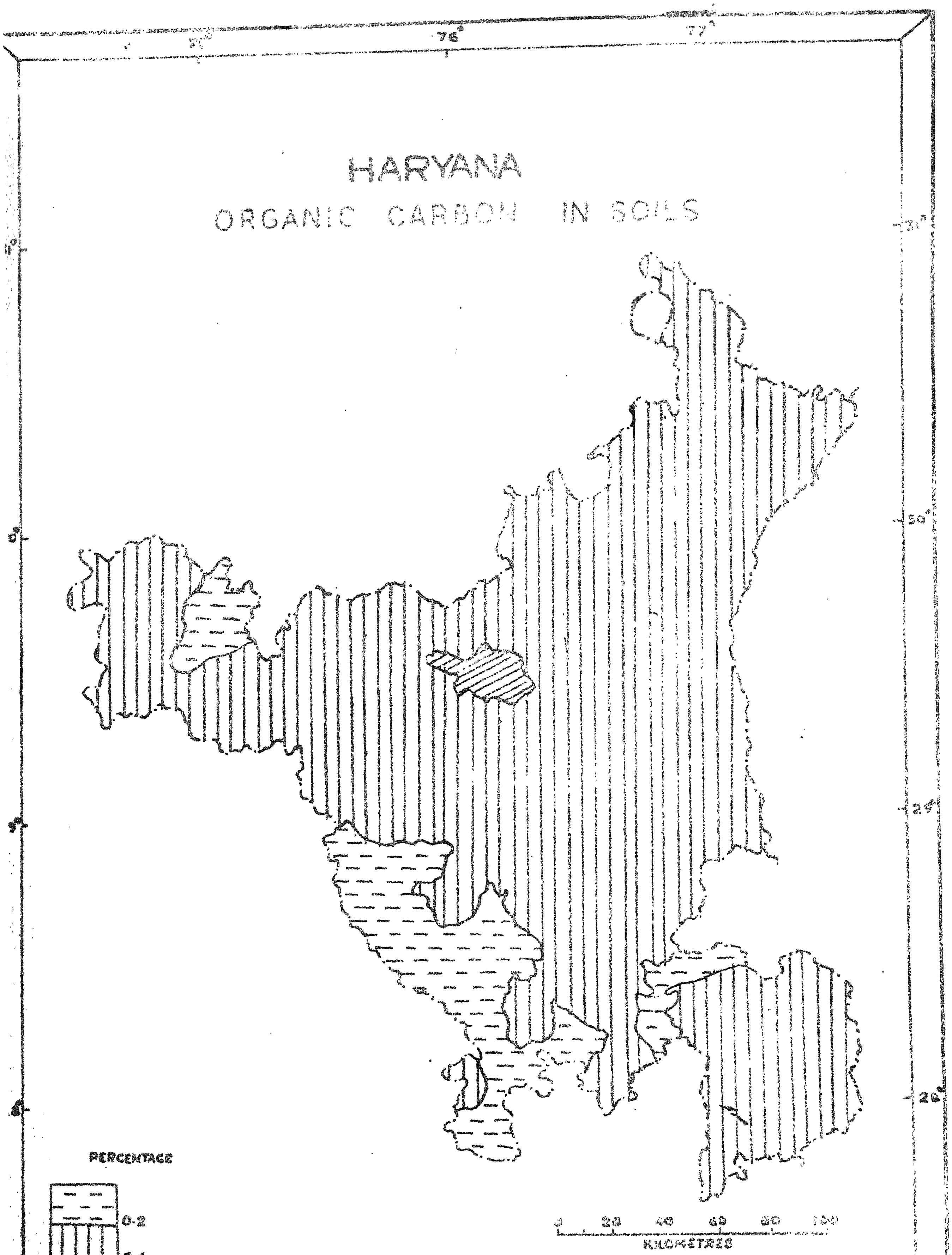
4.17 Agricultural Officers workshops are also held periodically, at least twice a year, to enable Haryana Agricultural University scientists and extension wokers and officials of the department of agriculture to work out cropping recommendations on the basis of their field experience. In the last three or four years, farmers specially those with farms of 4 to 6 hectares- which comprise the major portion of cropped area, have taken advantage of the suggested combination of crops and rotation of crops. Nevertheless, the main emphasis still remains upon foodgrains, which, depending on the area, means wheat or rice. Though Bajra and Gram are grown, they have now become supplementary crops or crops which are sown in the absence of rain or assured irrigation.

4.18 In this study, we will, therefore, concentrate on the use of fertilisers for maximum yield of wheat and rice on irrigated land only in order to narrow down the field of discussions. For the purpose of demonstratin the managerial principle of optimisation and also for immediate practical reasons it will be assumed that the farmers will use the practices to which they are already accustomed.

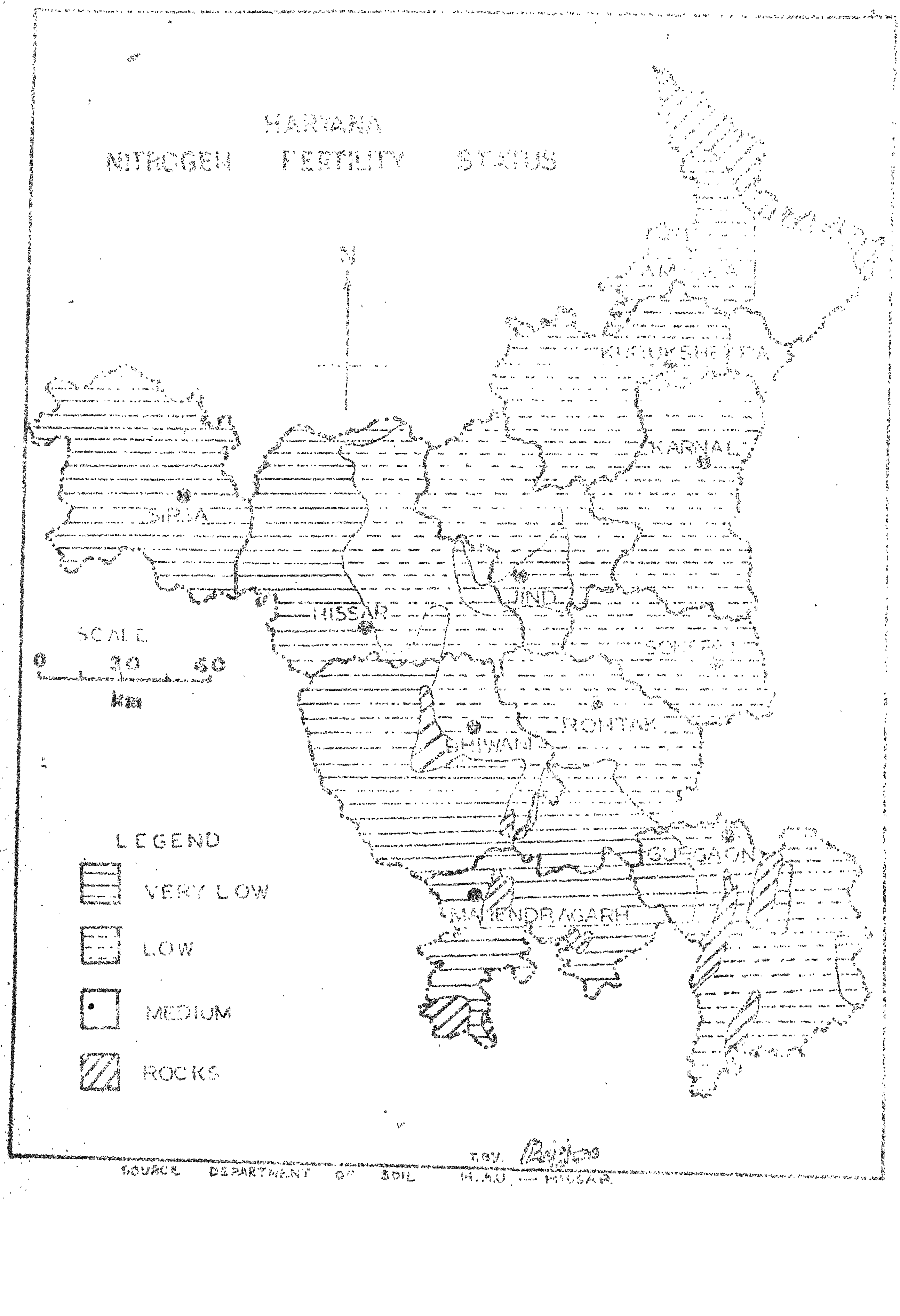
4.19 The most vital question of cropping pattern is in what manner we want the fertilizer to be used. What is our objective ? Do we simply want to maximise out-put per acre ? In other words is arable land the major constraint ? Or is it more necessary to maximise the out-put per unit of fertilizer, since this is a very costly input. Even in 1977-78, the large amounts have had to be imported and we are spending a fortune on setting up the fertilizers production units. What will be the most profitable for the individual farmers and what will be better for society as a whole ? We will see that diminishing returns may start fairly early and there is scope to explore an extensive margin which may greatly increase crop response to fertilizers. A contrast between the cropping pattern and negligible

use of fertilizers by the smaller farmers and the input of fertilizer used in large farms shows the extent to which irrational combination of input exists for society as a whole.

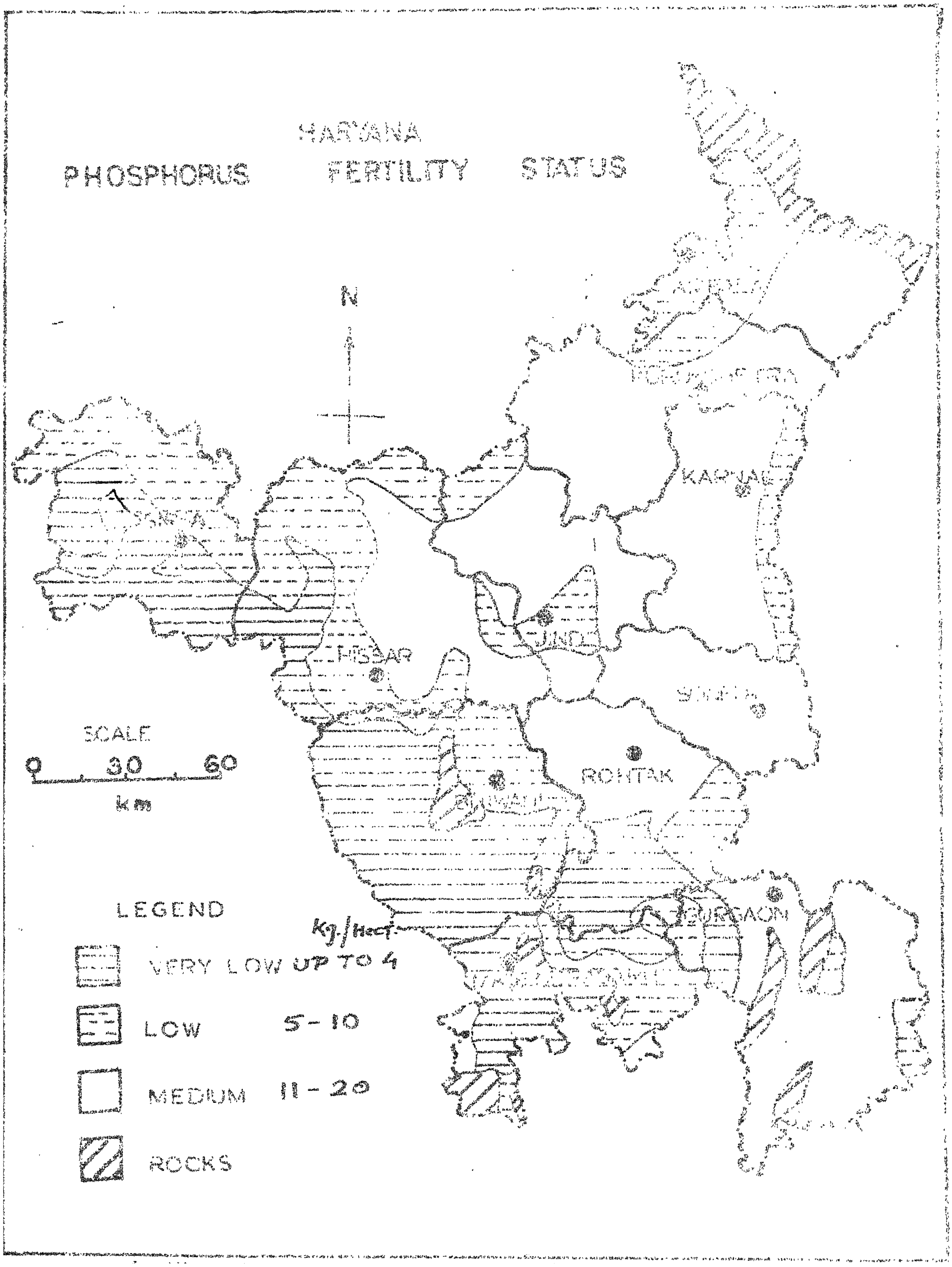

HARYANA
SOIL FERTILITY STATUS
N %
P Kg/ha
K Kg/ha
VERY LOW MEDIUM MEDIUM
VERY LOW MEDIUM HIGH
LOW LOW HIGH
LOW MEDIUM MEDIUM
LOW HIGH MEDIUM
LOW HIGH HIGH
MEDIUM LOW HIGH

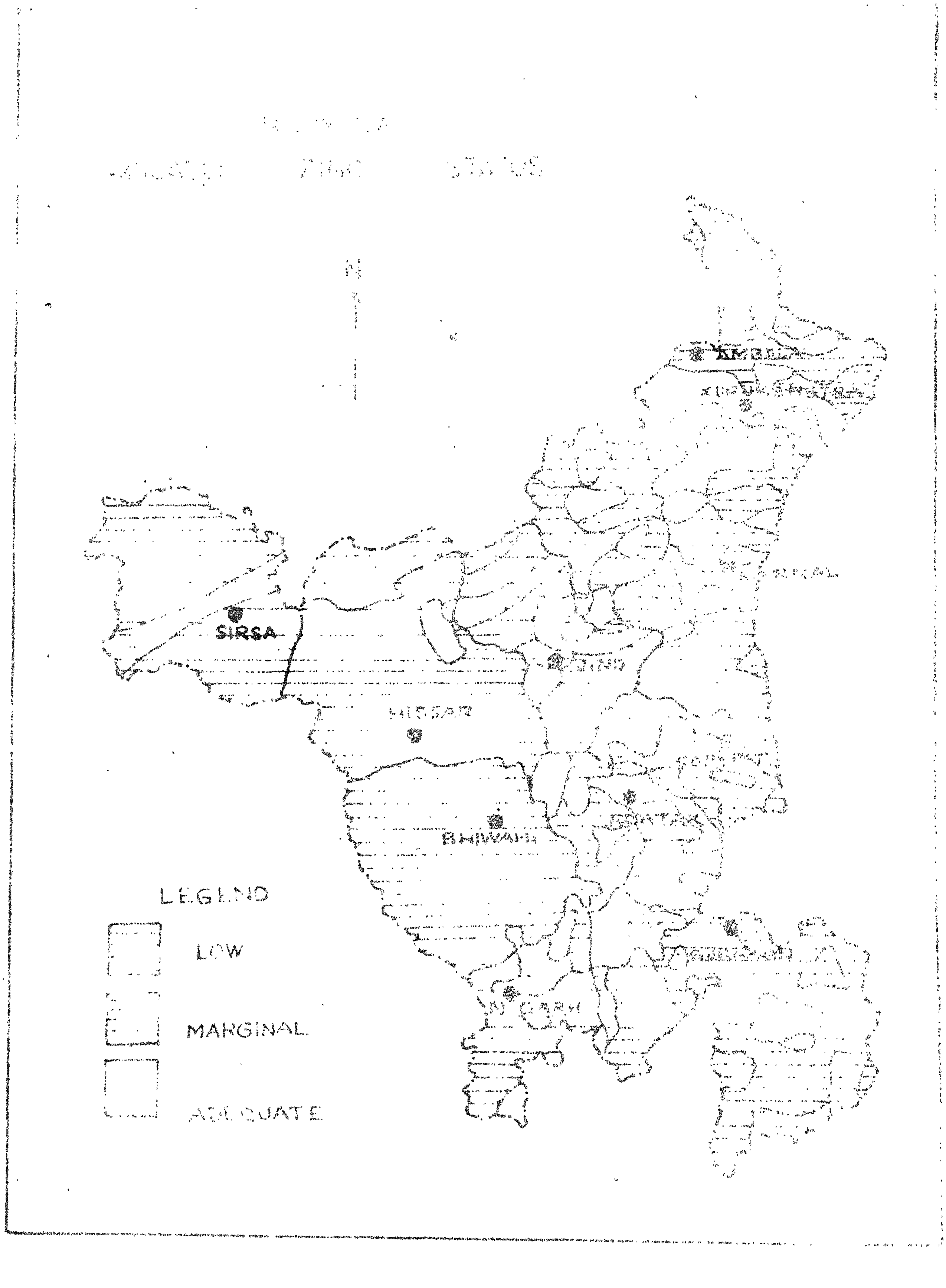


HARYANA
ORGANIC CARBON IN SOILS
PERCENTAGE
0.2
0.4
0.75
1974
0 20 40 60 80 100
KILOMETRES
75°
76°
77°



SOURCE DEPARTMENT OF SOIL H.A.U. — HISSAR


HARYANA
PHOSPHORUS FERTILITY STATUS
N
SCALE
0 30 60
km
HISSAR
JIND
KARNAL
ROHTAK
GURGAON
LEGEND
Kg./Hect.
VERY LOW UP TO 4
LOW 5-10
MEDIUM 11-20
ROCKS


AMBALA
SIRSA
JIND
HISSAR
BHIWANI
LEGEND
LOW
MARGINAL
ADEQUATE

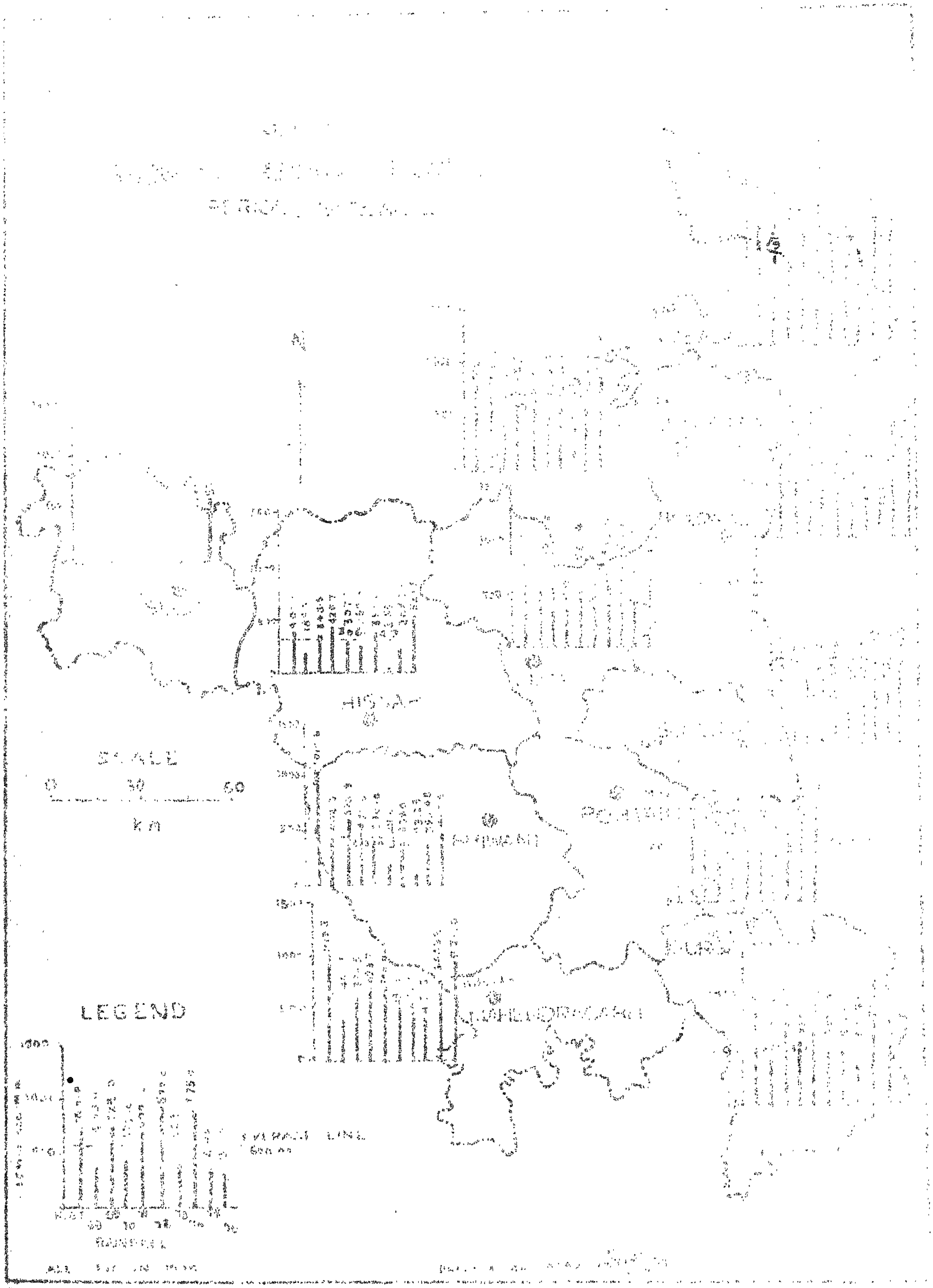

SCALE
0 30 60
km
LEGEND
BHIWANI
MAHENDRAGARH

Table 4.1

Statement showing the crop-wise percentage irrigated area for the year 1975-76.

District :

For the Year 1975-76

Crops	Hissar Total Area	Irr. Ar.	%age irr.are.	Sirsa Total area.	Irr. Ar.	%age irr. area.	Shiwani Total Area	Irr. Are.	%age ir Area.
Rice	8	8	100.0	13	13	100	-	-	-
Bajra	167	37	22.2	62	11	17.7	275	17	6.2
Maize	3	3	100.0	1	1	100.0	-	-	-
Jowar	7	6	85.7	2	2	100.0	9	5	55.6
Kh.pulses	3	1	33.3	4	1	25.0	19	-	-
G.Nut	-	-	-	-	-	-	-	-	-
Other Khf. seeds.	-	-	-	-	-	-	-	-	-
S.Cane	8	8	100.0	1	1	100.0	5	5	100.0
Cotton	122	122	100.0	74	73	98.6	10	10	100.0
Kharif fodder & other minor crops	89	46	51.7	45	23	51.1	71	13	18.3
al Kh. ops	407	231	56.8	202	125	61.9	3892	50	12.9
Wheat	123	123	100	84	81	96.4	30	30	100.0
Gram	182	104	57.1	147	34	23.1	257	57	22.2
Barley	14	13	92.9	11	7	63.6	6	4	66.7
R.Pulses	2	2	100.0	-	-	-	-	-	-
R.Oil seeds.	32	17	53.1	19	10	52.6	7	3	42.9
Potato	-	-	-1	-	-	-	-	-	-
R.Fodder & other minor crops.	19	19	100.0	10	10	100.0	3	2	66.7
al Rabi . ops	372	278	747	271	142	52.4	303	96	31.7
nd total l & Khr. & ops.	779	509	65.3	473	267	56.4	692	146	21.1

Statement showing the crop-wise percentage irrigated area for the year 1975-76.

District:

For the year 1975-76

Crops	Rohtak Total Area	Irr. Ar.	%age irr. are.	Sonepat Total area.	Irr. area.	%age irr. area.	Gurgaon Total area	Irr. Are.	%age irr. area.
1. Rice	2	2	100.0	8	8	100.0	3	1	33.3
2. Bajra	108	7	6.5	22	2	9.1	101	3	3.0
3. Maize	1	1	100.0	6	3	50.0	6	2	33.3
4. Jowar	52	12	23.1	23	7	30.4	35	2	5.7
5. Kh.pulses	-	-	-	1	1	100.0	1	-	-
6. G.Nut	-	-	-	-	-	-	1	-	-
7. Other Khf. seeds.	-	-	-	-	-	-	1	-	-
8. S.Cane	29	-	100.0	21	20	95.2	11	11	100.0
9. Cotton	6	6	100.0	4	4	100.0	1	1	100.0
10. Kharif Fodder & other minor crops.	35	6	17.1	14	6	42.9	42	6	14.3
Total Kh.crops	233	63	27.0	99	51	51.5	202	26	12.9
11. Wheat	115	98	85.2	102	86	84.3	158	117	74.1
12. Gram	110	26	23.6	17	3	17.6	63	5	7.9
13. Barley	13	8	61.5	6	2	33.3	57	24	42.1
14. R.Pulses	4	1	25.0	3	2	66.7	10	1	10.0
15. R. il seeds	10	3	30.0	3	2	66.7	18	3	16.7
16. Potato	-	-	-	-	-	-	-	-	-
17. R.Fodder and other minor Crops	6	5	83.3	9	8	88.9	6	4	66.7
Total Rabi crops	258	141	54.7	140	103	73.6	312	154	49.4
Grand total Rabi & Khr.& crops.	491	204	41.5	239	154	64.4	514	180	35.0

Table 4.1 cont

Statement showing the crop-wise percentage irrigated area for the year 1975-76.

District:

Crops	Karnal Total Area.	Karnal Irr. Ar.	Karnal %age irr. area.	Kurukshetra Total area.	Kurukshetra Irr. Ar.	Kurukshetra %age irr. Area.	Ambala Total area.	Ambala Irr. area.	Ambala %age irr. Area
	For the year 1975-76								
1. Rice	88	87	98.9	116	115	99.1	49	25	51.0
2. Bajra	11	1	9.0	20	4	20.0	5	-	-
3. Maize	31	10	32.3	36	14	38.9	49	2	4.1
4. Jowar	5	1	20.0	4	2	50.0	-	-	-
5. Kh. Pulses	1	1	100.0	1	1	100.0	5	-	-
6. G.Nut	-	-	-	-	-	-	10	-	-
7. Other Kh. oilseeds	1	-	-	1	-	-	-	-	-
8. S.Cane	20	18	90.0	15	14	93.3	29	16	55.2
9. Cotton	5	4	80.0	8	8	100.0	2	-	-
10. Kharif fodder & other minor crops	34	14	41.2	36	11	30.6	40	5	12.5
Total Kh. crops	196	136	69.4	237	169	71.3	189	48	25.4
11. Wheat	180	170	94.4	193	186	96.4	105	59	56.2
12. Gram	22	5	22.7	41	10	24.4	40	1	2.5
13. Barley	9	5	55.6	15	8	53.3	8	1	12.5
14. R. Pulses	6	2	33.3	5	2	40.0	8	-	-
15. R. oil seeds	6	3	50.0	8	5	62.5	6	1	16.7
16. Potato	2	2	100.0	5	5	100.0	3	3	100.0
17. R. fodder & other minor crops	27	25	92.6	24	24	100.0	16	7	43.7
Total Rabi crops	252	212	84.1	291	240	82.5	186	72	38.7
Grand Total Kh. & Rabi crops	448	348	77.7	528	409	77.5	375	120	32.0

Table 4.1 Cont.

Statement showing the crop-wise percentage irrigated area for the year 1975-76.

District:

For the year 1975-76

Crops	Jind Total Area	Jind Irr. Ar.	Jind %age irr. are.	Mohindargarh Total Area	Mohindargarh Irr. Ar.	Mohindargarh %age irr. are.
1. Rice	16	16	100.0	-	-	-
2. Bajra	94	31	33.0	139	-	-
3. Maize	5	3	60.0	-	-	-
4. Jowar	22	13	59.1	3	-	-
5. Kh.Pulses	-	-	-	2	-	-
6. G.Nut	-	-	-	-	-	-
7. Other Kh. oilseeds	1	-	-	-	-	-
8. S.Cane	20	20	100.0	-	-	-
9. Cotton	22	22	100.0	-	-	-
10. Kharif fodder & other minor crops.	27	15	55.6	39	1	2.6
Total Kh. crops.	207	120	58.0	183	1	0.5
11. Wheat	102	99	97.1	39	37	94.9
12. Gram	102	60	58.8	127	1	0.8
13. Barley	12	8	66.7	29	22	75.8
14. R.pulses	4	4	100.0	-	-	-
15. R.oil seeds	13	9	69.2	16	1	6.2
16. Potato	-	-	-	-	-	-
17. R.fodder & other minor crops	13	13	100.0	2	2	100.0
Total Rabi crops	246	193	78.5	213	63	29.6
Grand total Kh.& Rabi	453	313	69.1	396	64	16.2

Table 4.2

STATEMENT SHOWING UTILISATION OF SUPPLIES FROM BHAKRA INCLUDING RAVI, BEAS RIVER YAMUNA, AUGMENTATION TUBEWELLS, BIBIPUR LAKE, GHAGGAR RIVER AT OTTU, GURGAON CANAL AND U.P. CHANNELS OF AGRA CANAL IN HARYANA STATE FROM 1965-66 to 1975-76 (ALL FIGURES in cusecs days)

DESCRIPTION	1975-76 Kharif	Rabi	Total	Remarks
1. BHAKRA CANAL SYSTEM i) Bhakra canal system including Ravi Beas water.	1097238	1172236	2269474	i) Supplies Utilised from Bhakra Ravi-Beas are excluser supplies delivered to Rajasthan, Punjab Delhi Water Supply 'C' Thermal Station, Gurgaon Canal out of Haryana Ravi-Beas share, Diversion to W.J.C. area.
ii) Tubewell supplies from Augmentation T/Wells along Ratia Branch and Bhakra Main Branch.	6350	9800	16150	ii) Based on figures obtained from M.I.T.C.
2. W.J.C. System i) W.J.C. system including Chautang Feeder.	937829	837338	1775167	i) Based on figures from register of 10 daily discharge of Drawing Branch
ii) Cut off channels of Chautand Feeder System.	14088	2985	17073	ii) Obtained from Xen/ Karnal Division, Karnal
iii) Tubewell supplies from Augmentation Tubewells along Delhi parallel Branch.	3050	12330	15380	iii) Based on figures obtained from M.I.T.C.
iv) Tubewells supplies from Aug. T/wells along Hansi Branch & Butana Branch.		5254	5254	
3. Supplies utilised in Haryana channels from Bibipur Lake.	27937	5659	33596	Based on figures obtained from Xen/Pehowa Divn. Kaithal.

......./2

4. Ghaggar Water utilised in Haryana channels to Ottu Lake.	92454	22754	115208	Based on figures obtained from S.E./H.B.C.
5. GURGAON CANAL SYSTEM				
i) Gurgaon canal system.	19663	34734	54397	Based on data from register of crop-wise totals maintained in Drawing Branch.
ii) Tubewell supplies from Augmentation T/wells along Gurgaon Canal.	-	2034	2034	
6. U.P. channels of Agra Canan serving Haryana area.	18855	44418	63273	Based on figures supplied by Xen/ Faridabad.
Total without Agra Canal	2198609	2105124	4303733	
Total with Agra Canal	2217464	2149542	4367006	

NET AREA UNDER IRRIGATION IN HARYANA STATE

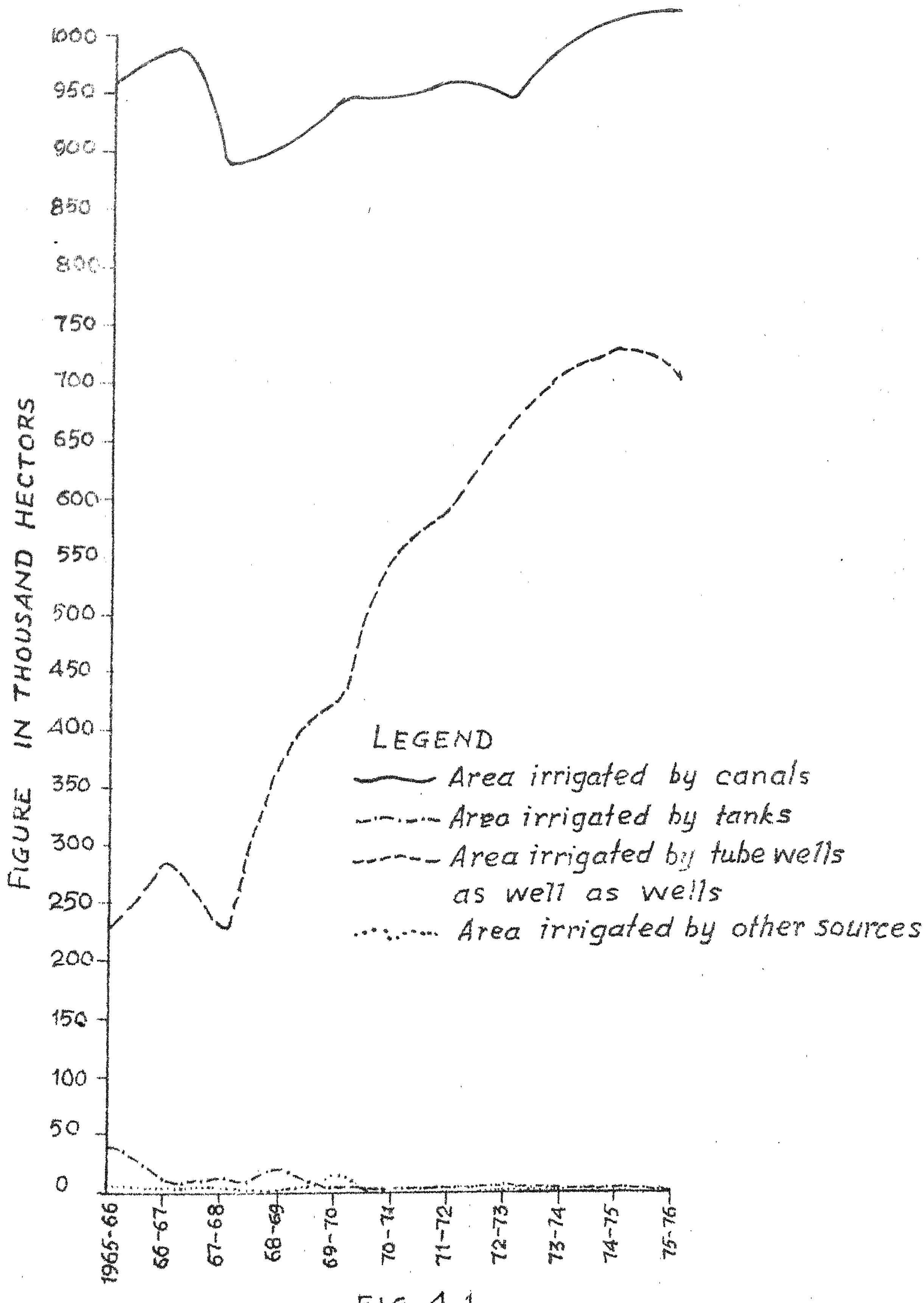


FIG. 4.1

GROWTH OF AREA UNDER H.Y.V OF WHEAT
DISTT. GURGAON
PERIOD 1965-66 TO 1976-77

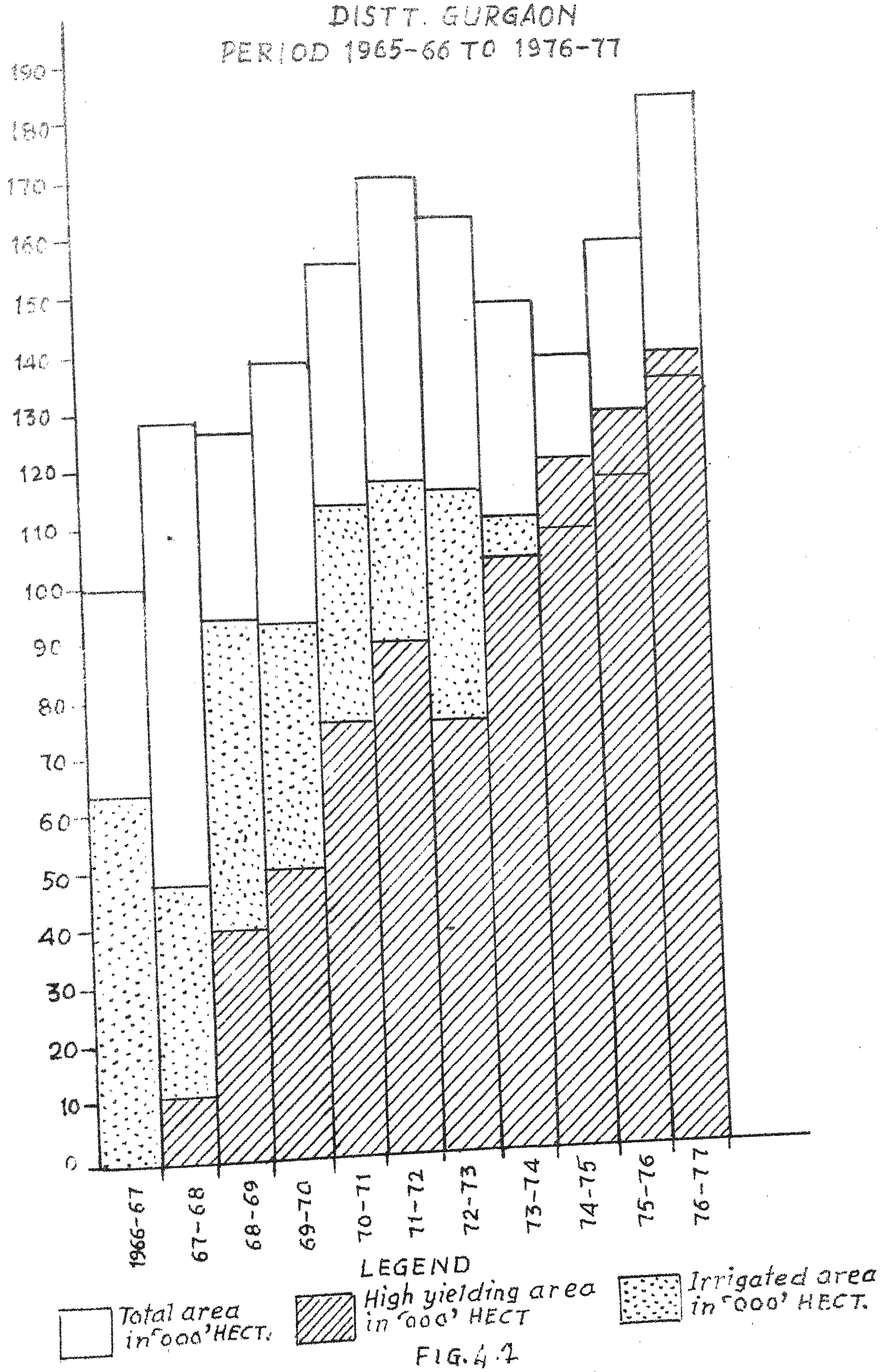


FIG. 4.2

GROWTH OF AREA UNDER H.Y.V. OF WHEAT
DISTT. ROHTAK
PERIOD 1966-67 TO 1976-77

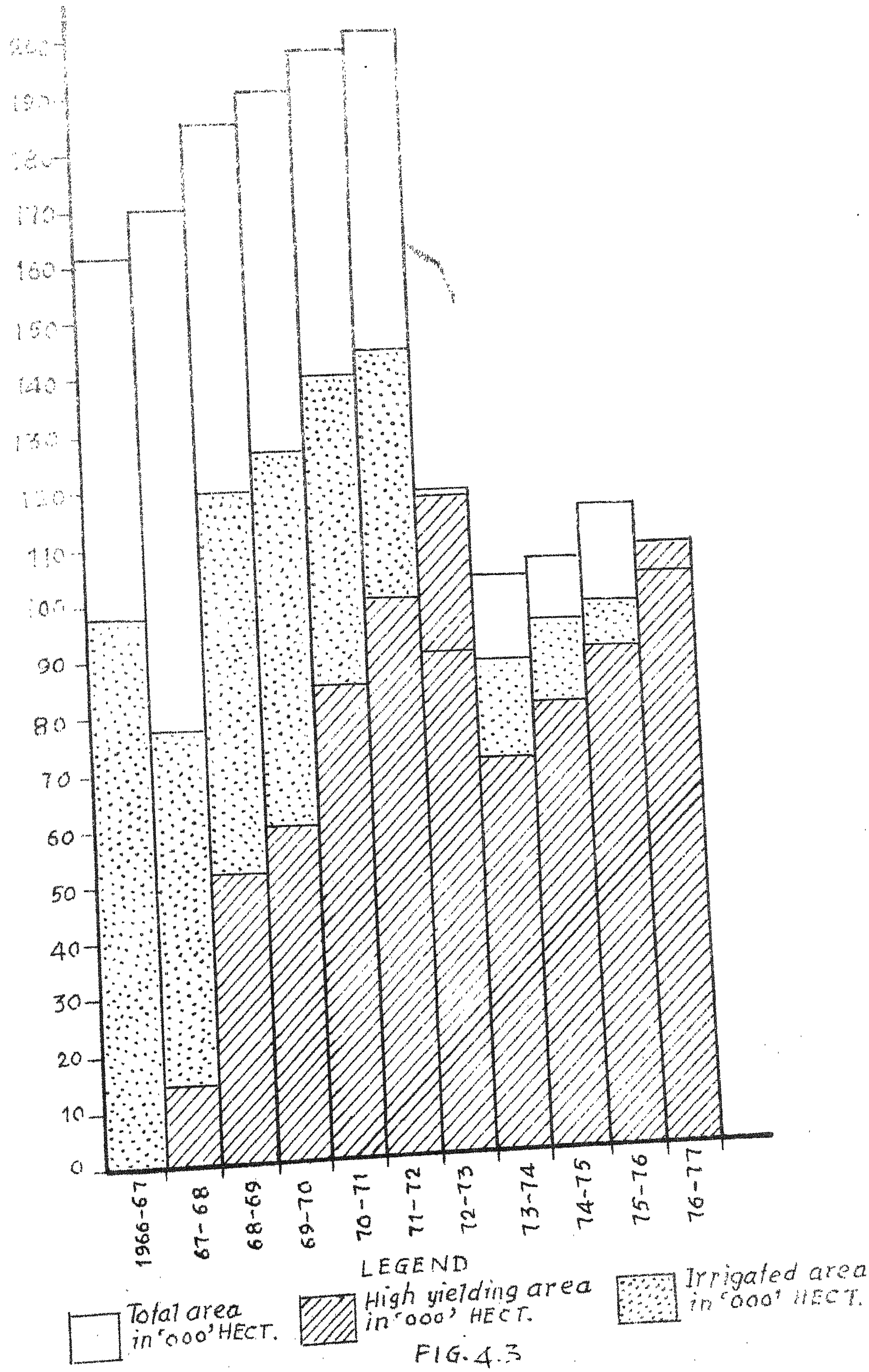


FIG. 4.3

GROWTH OF AREA UNDER H.Y.V. OF WHEAT

PERIOD 1965-66 TO 1976-77

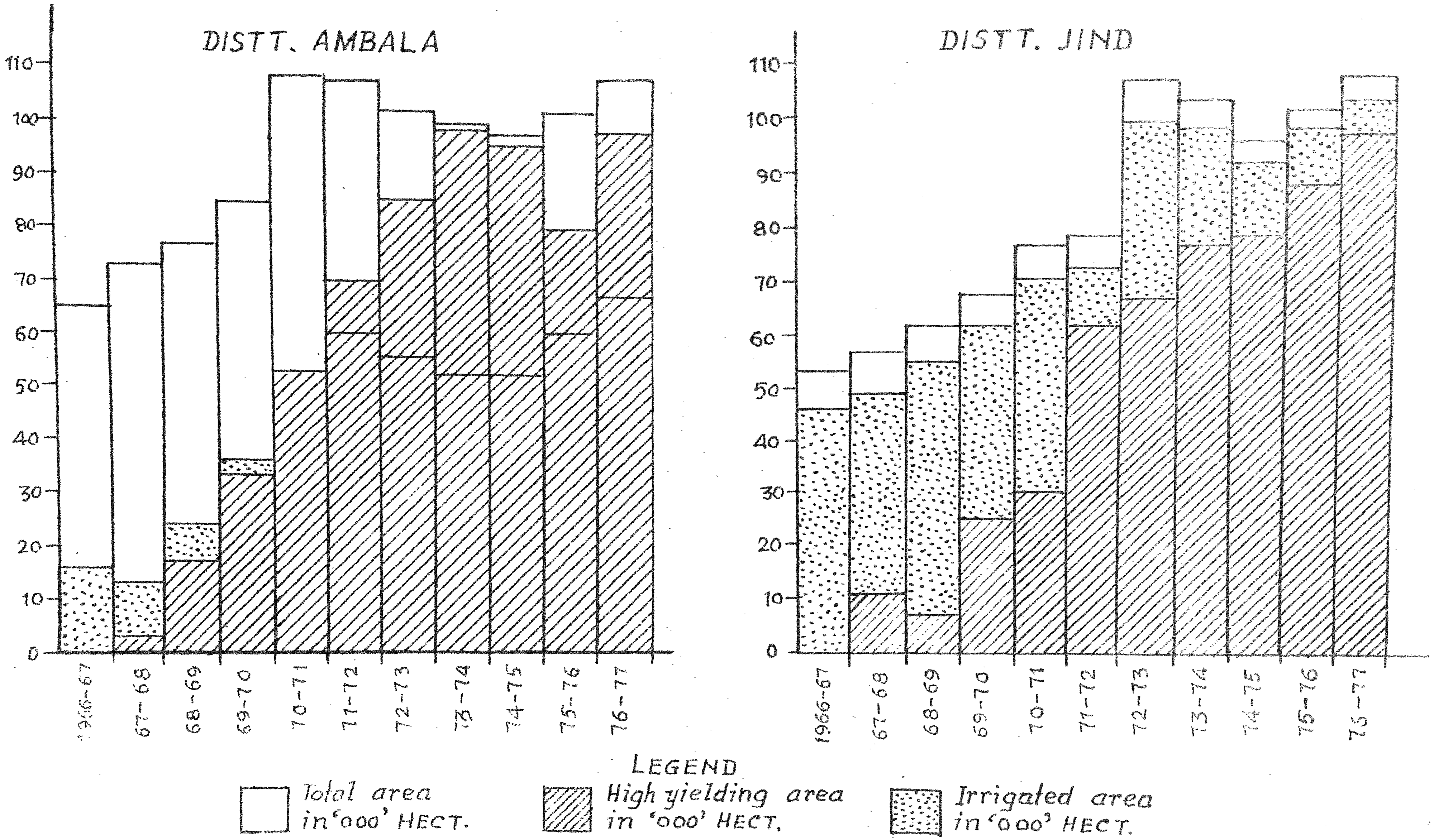


FIG. 4.A

GROWTH OF AREA UNDER H.Y.V. OF WHEAT
DISTT. KURUKSHETRA
PERIOD 1965-66 TO 1976-77

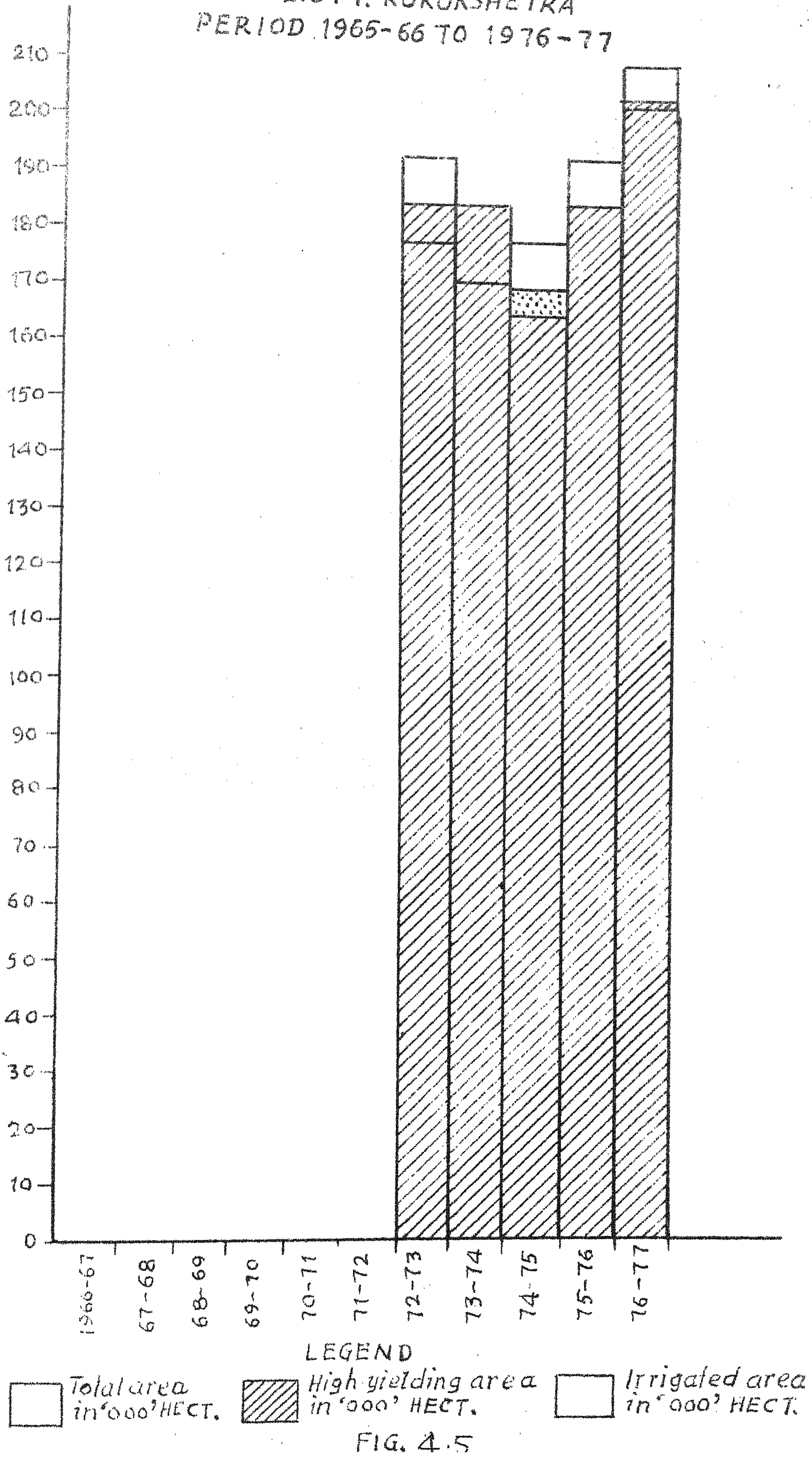


FIG. 4.5

GROWTH OF AREA UNDER H.Y.V. OF WHEAT
DISTT. KARNAL
PERIOD 1965-66 TO 1976-77

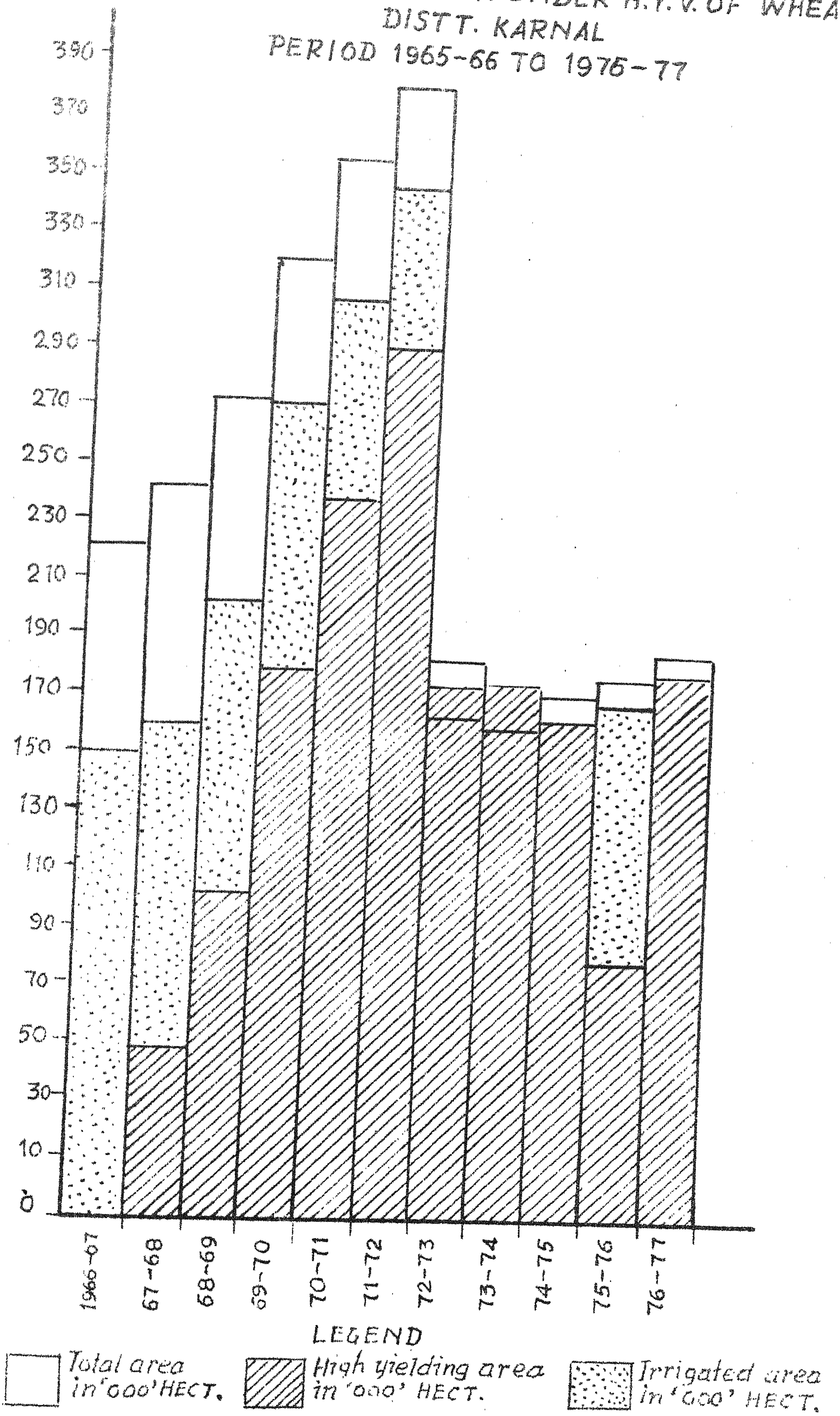


FIG. 4.6

GROWTH OF AREA UNDER H.Y.V. OF WHEAT

PERIOD 1965-66 TO 1976-77

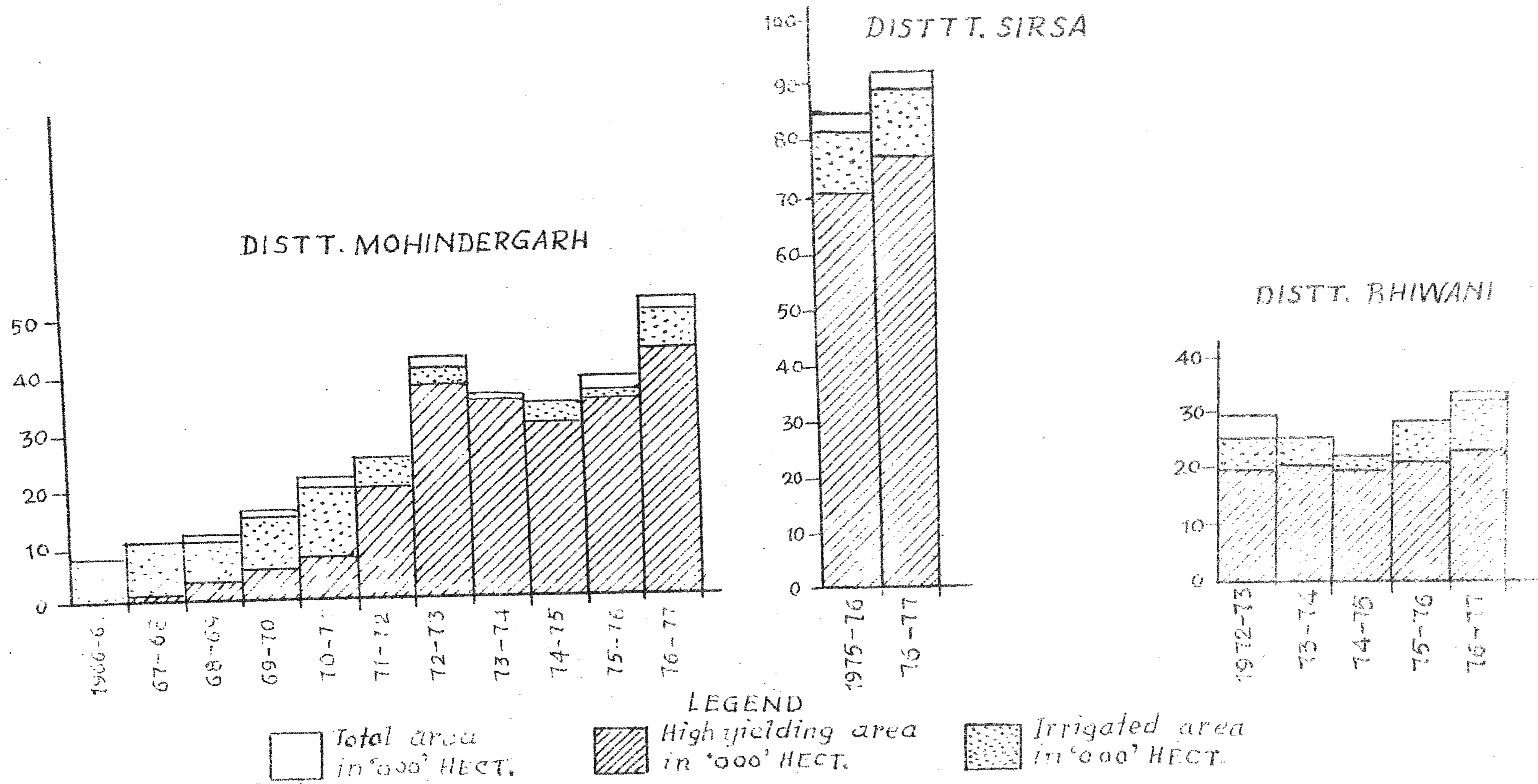


FIG 4.7

TOTAL IRRIGATED & HIGH YIELDING AREA UNDER WHEAT CROPS IN HARYANA STATE
PERIOD 1965-66 TO 1976-77

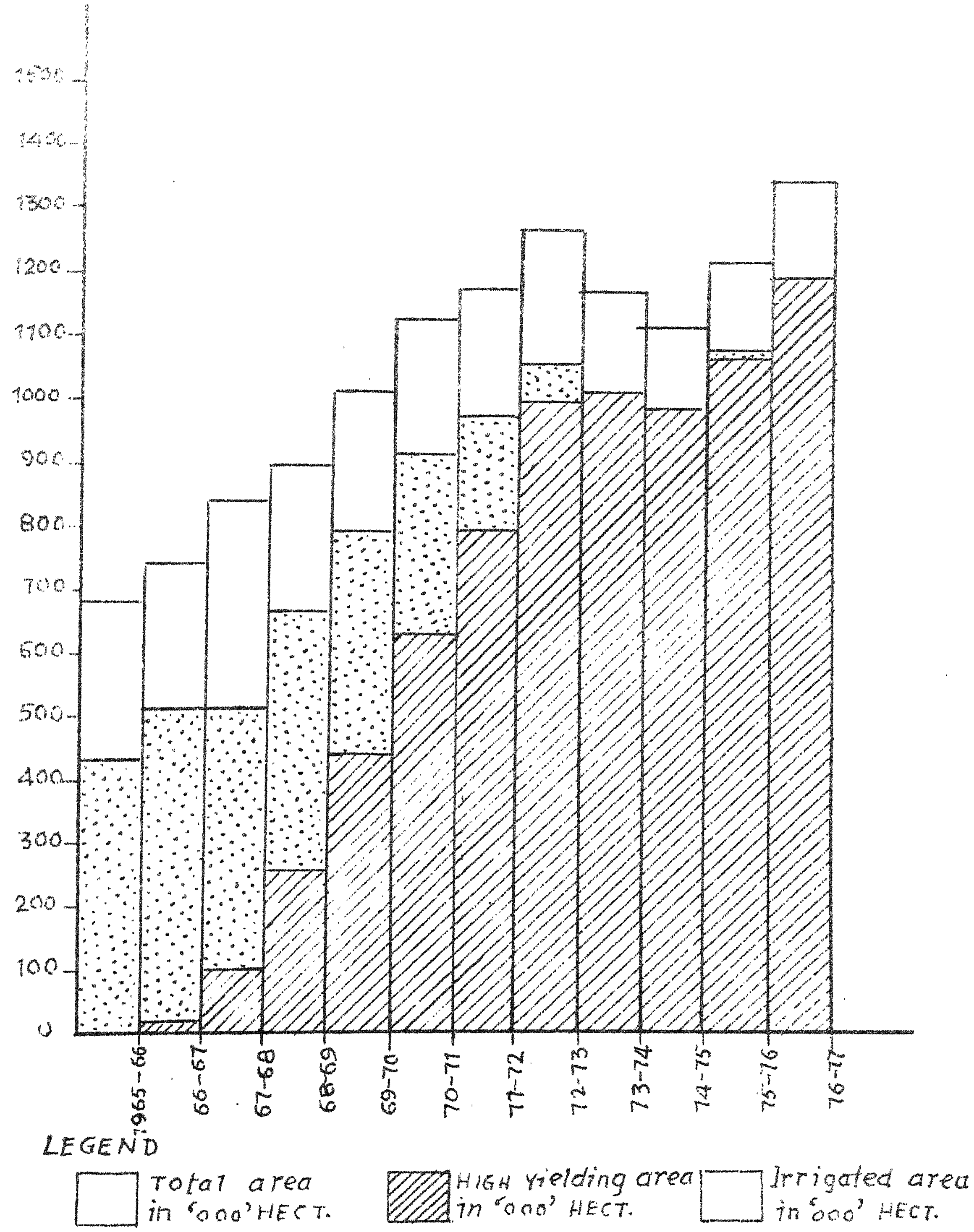
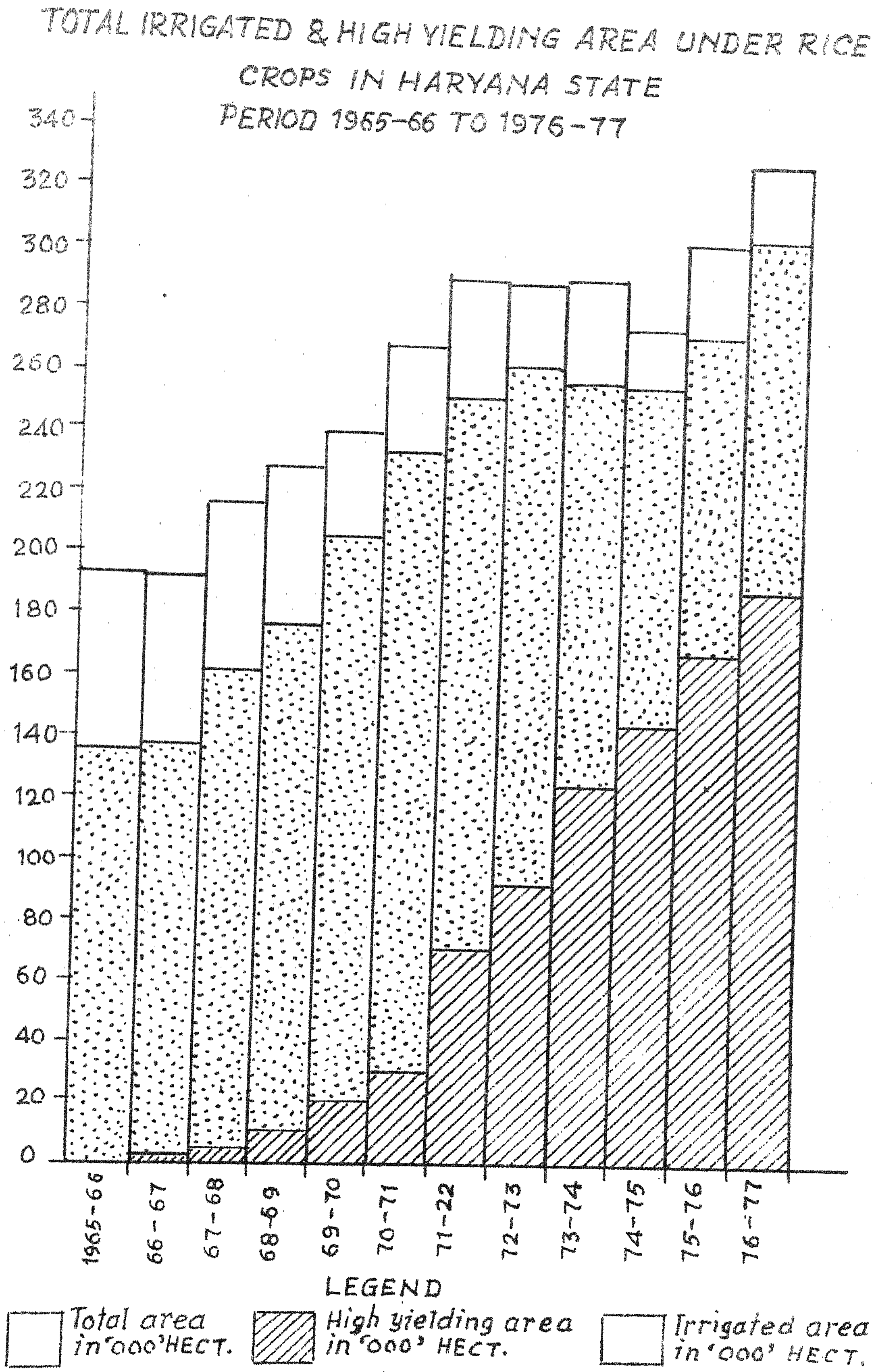


FIG 4.8



TOTAL IRRIGATED & HIGH YIELDING AREA UNDER RICE CROPS IN HARYANA STATE
PERIOD 1965-66 TO 1976-77
340
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
1965-66
66-67
67-68
68-69
69-70
70-71
71-22
72-73
73-74
74-75
75-76
76-77
LEGEND
Total area in'000'HECT.
High yielding area in '000' HECT.
Irrigated area in '000' HECT.

FIG. 4.9

V

Crop Response to Fertiliser

Role of Fertiliser in Crop Production

The necessity for the addition of chemical fertilisers will appear if we consider the effect of cultivation upon the major, secondary and micro elements of plant nutrients present in the soil. The major nutrients are Nitrogen, Phosphorous and Potassium, secondary nutrients are Calcium, Magnesium and Silver, and micro nutrients are Boron, Chlorine, Copper, Iron, Magnesium, Molybdenum and Zinc. We should also note that when fertilisers and manures are added from outside they react with the soil constitu-ents and alter the balance of elements. The amount of nutrient removed by the crops is usually calculated by an analysis of the straw and grains production by that crop. A number of research reports suggest that the production of foodgrains and non foodgrain crops during 1970-71 resulted in the removal of about 12 million tonnes of nutrients ($N + P_2O_5 + K_2O$) in the ratio of $N : P_2O_5 : K_2O$ = 1:04 : 1.6. For the projected production of foodgrains and non-foodgrain crops during 1980-81, the National Commission on Agriculture (1976) calculates that the depletion of

nutrients is likely to be of the order of 18 million tonnes. Obviously the quantity of fertilisers added to the soil ever year is mostly inadequate to replace the loss of fertility. In fact, we have depended on natural recuperation, supplemented by the growing of legumes. Anaerobic conditions of flooded rice fields, for instance, have encouraged the growth of several forms of algae which are known to fix atmospheric nitrogen. Nitrogen is a fugitive constituent of the soil and subject to transformation, but loss from the soil is mainly due to farming, vegetation leaching and de-nitrification. Gain is through rain water, a symbiotic process in the roots, nodules of pulses and free living nitrogen fixing organisms. The net annual increase due to these factors is about 1 to 1.5 million tonnes of N to 24 million hectares of land under legumes. Since we add just about 1.8 million tonnes of chemical fertilisers per annum to the soil, the difference between two sources is,at present, not substantial. With the growth of High Yielding varieties of food-grains, it is necessary to supplement the plant nutrient from outside sources. These are, as we have already stated:

(a) chemical fertilisers which are ultimately responsible for adding vegetable matter in the form of plants roots and residues;

(b) farm yard manures, compost, etc. which increase soil humus; and

(c) soil amendments which are primarily used for the correction of favourable soil conditions, such as soil alkanity.

Some of the chemicals used as weedicide or pesticides may also act as growth regulating factors.

The experience in I.A.D.P. districts shows that simple application of nitrogen is no longer adequate. In the more progressive farms in Punjab and Haryana, which are considered here, the trend is now towards more balanced use of fertiliser. Under the All India Co-ordinated Agronomic Experiments Scheme, it has been found that inter-action between Nitrogen and Phosphorous is significant on a number of crops and was generally positive. Not only higher yields but more effective utilisation of both nitrogen and phosphorous resulted.

In the case of phosphatic fertilisers, the

sources may be divided into two categories. Rock phosphates are basic materials for the manufacture of practically all water soluble and citrate soluble; and basic slag which can be applied in powdered condition directly to acid soils but cannot be used in mixed fertiliser. The former, i.e. the rock phosphate is better utilised in the manufacture of citrate soluble phosphate, since the water soluble phosphate tends to be converted into iron and aluminium phosphate. The effectiveness of the soluble form may be questioned because of the tendency to conversion into insoluble form, but in the absence of valid experimental proof, no conclusion can be drawn. Phosphorus should be applied by drilling it into the soil with the seed.

Potassic fertilisers are all water soluble and the problem of K fixation in soils is not as acute as it is for P. It is usual to apply K prior to or at planting by broadcast method. The timing however, is very important and regions of high rainfalls benefit by split application to avoid leaching. Potassium once thought to be present in sufficient quantities in the soil is now found to

be required in high yielding crops and in high raifall areas.

The cultivators' field trials also confirm that interaction between the nutrients is significant. Positive results were obtained in 8 districts out of 15 districts for rice and 16 out of 19 district for wheat. It is, however, necessary to determine the exact requirements of nutrients to be added to the soil because sometimes for reasons not fully understood interaction is negative. The soil profile, as we have already mentioned, show that with the application of large doses of major nutrients in Haryana the limiting factor has turned out to be Zinc.

There has been a spectacular yield increase of High Yielding Varieties of wheat and paddy by the application of Zinc, the doses of which are much above the usual doses of micro-nutrients. Because of the high requirements of these varieties, Zinc is better applied as sulphide though sometime oxides are equally good.

In the case of Haryana soil amendment like

Gypsum, as already noted, is an important part of the fertiliser programme.

There is, however, an important proviso. It is well known that the nutrient which has direct influence on the metabolic activity of plant is that which prevails in the body of the plant itself. The availability of fertilisers to the plant is not necessarily in the same proportion as they are applied to the soil. Consumption ratios of the N,P & K fertilisers will have little meaning unless calculated in terms of the ionic forms in which the nutrients are taken up. We cannot use international comparisons because of the completely different utilisation ratios of fertilisers under tropical conditions. Nitrogen utilisation, for instance, is much less in tropical countries as there is great deal of loss by leaching. That is why in this study, we will be using the nutrient ratio in the recommended doses for various crops rather than general consumption ratio and the former are much narrower than the latter.

As previously noted in this chapter, the nutrient must be supplied at the time of demand by

plants if they are to be of efficient use. There are a fairly well demarcated performance for the growth of plants when nutrient demand are high. We have, therefore, to decide simultaneously what are :

(a) the most efficient form of fertiliser,

(b) the optimum time of application,

(c) best method of application, and

(d) zone of placement best suited for plant off-take.

Unfortunately, sufficient information on all these aspects is wanting, but different methods of application have now been experimented with including both drilling in of fertiliser with seed and later foliar sprays. Table 5.2 and Table 5.3 show the effects of methods of sowing and tillage upon crop yields. In the crop response function that we have set out, the field experiments did not use such foliar spray. On the other hand, the best use of nitrogen is assumed in these fields trials, i.e. split doses at appropriate periods with 5 to 6 watering at a minimum in the case of

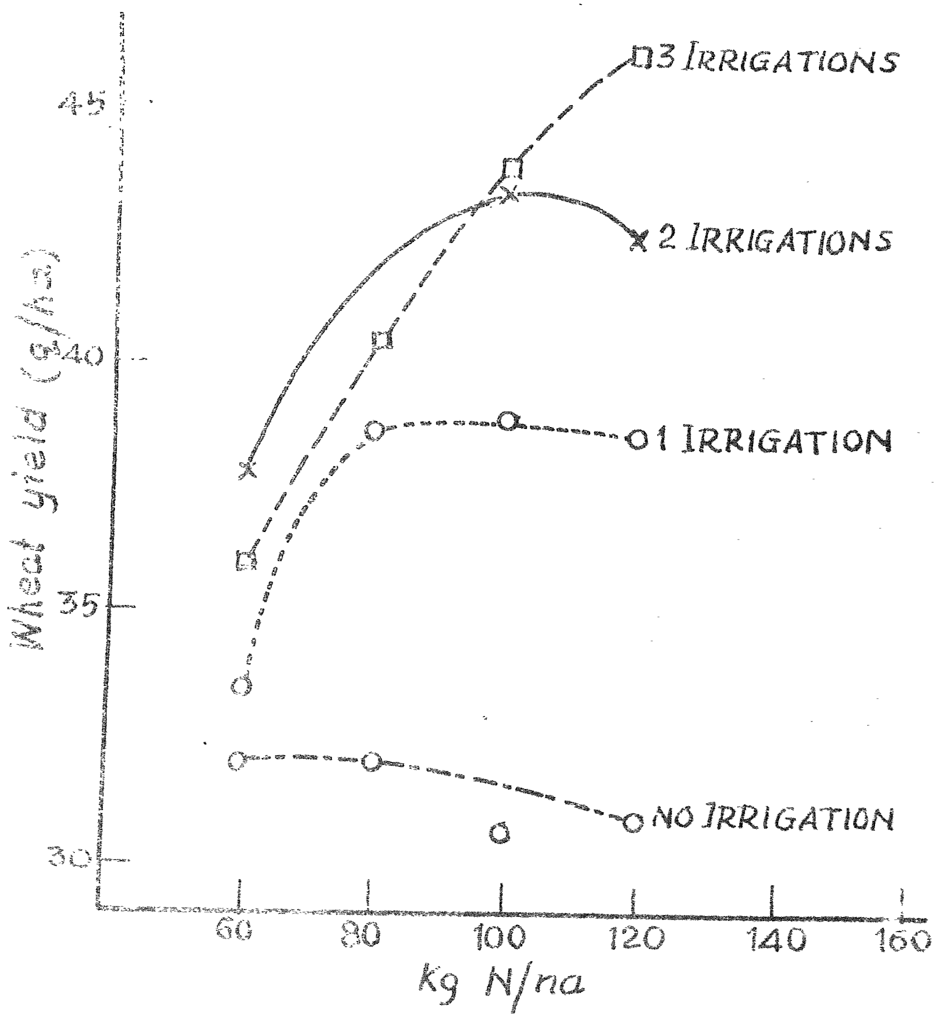


Fig.5.: Initial moisture storage-38 cm/180 cm profile

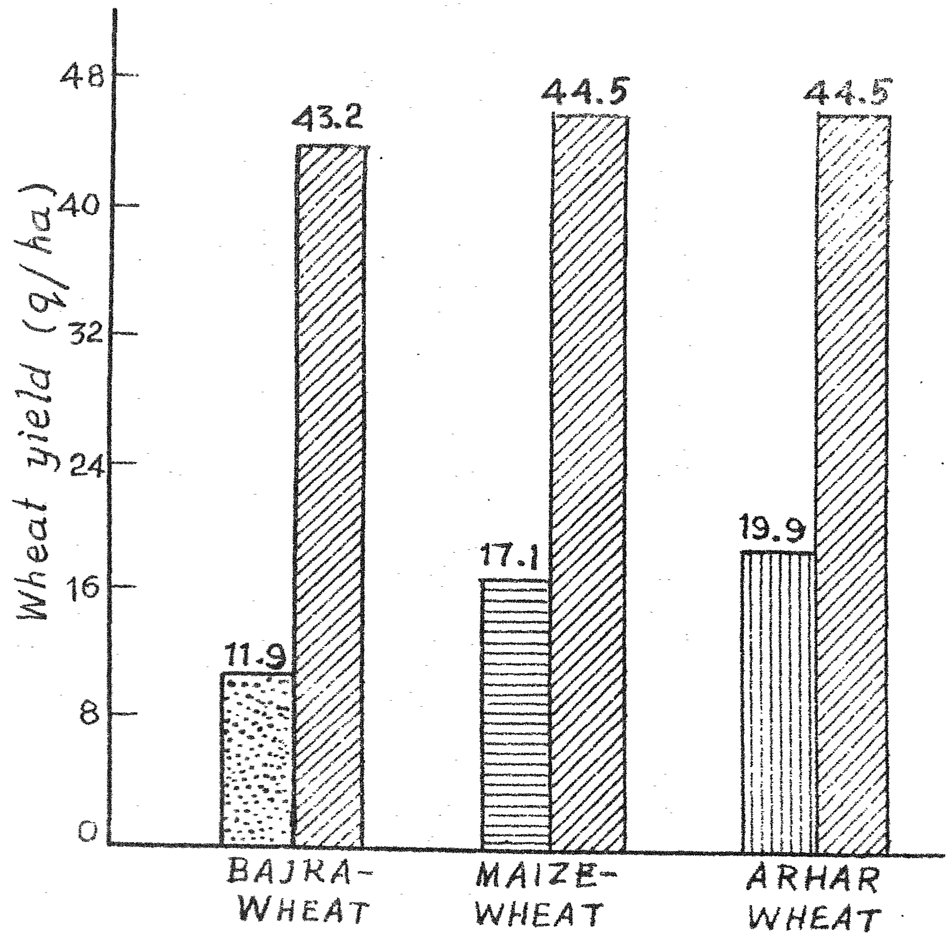


Fig.5 : Effect of preceding crop on the yield of wheat

nitrogen application. When rainfall is inadequate the magnitude of crop response to fertiliser application is itself a function of irrigation water supply(Figure 5.1). In order not to complicate the picture, we have not investigated the interaction between P and K with Nitrogen application. Nor have we included the effect of the preceding crop on the yield of wheat(Fig.5.2). But there is no reason why if sufficient trials are available, this cannot be included.

Crop Response Functions

A clear picture of the increase in yield of different crops to various doses of different fertilisers, here termed" crop response to fertilisers" is desirable not only to provide guidance to farmers for efficient use of fertilisers but is also necessary as basis for distribution of fertilisers between the regions. Such crop response is, in general, characterised by certain norms described in the following paragraphs.

Since crop production needs more than one input factor, response surfaces may be designated for any one such input. In this study, crop response will, however, always denote crop fertiliser

response unless specifically stated otherwise.

If i th type of input is designated as X_i and the output or yield(also known as Response or Production) by Y, then the quantity of output is determined by quantities of inputs i.e.

$$Y = f(X_1, X_2 \ldots\ldots\ldots\ldots\ldots X_n)$$

The functional relationship is termed as the response function or production function. Determination of the exact nature of function is by no means simple. However, three definite relationships have been observed between the inputs and outputs in crop responses.

i) There is a continuous smooth casual relationship between the x_i s(inputs) and Y(output). In the language of mathematics, this means that the first partial derivative $\partial y/\partial x_i$ of the response equation above should exist.

ii) Ultimately diminishing returns prevail with respect to each input factor. Thus additional output from successive units x_i becomes less and less, other factors

remaining fixed. It is indeed often observed that beyond some peak yield additional units of x_i becomes increasingly deleterious on yield. This implies that Y increases at first and ultimately decreases as X_i increases which in turn implies that $\partial y/\partial x_i$ is positive, zero and then negative. And the second partial derivative $\partial^2 y/\partial x_i^2$ is positive at first then zero and then negative.

iii) Decreasing returns to scale prevail i.e. ultimately an equal proportionate increase in all the input factors do not result an equal proportionate increase in output. Mathematically

$$\frac{(y/x_i)}{(\partial y/\partial x_i)} > 1 \qquad \text{for all } x_i.$$

The above theories have been developed based on contributions of Balmukund, Baule, Heady, Michterlich, Jensen, Liebig and others.

Though the above theories of response are generally applicable to the important inputs, that may not always be true depiction in the situation obtaining

particularly for inputs like micro-nutrients where a discontinuous theory of response might be preferable. For particular domains, fertiliser inputs may sometimes show increasing-returns characteristics also.

On the basis of above fundamental characteristics of Crop Fertiliser Response, many functional forms connecting one input and output can be found which are continuous and will show diminishing returns. Some of the commonly used Fertiliser Response curves are discussed below:

(i) Michterlich Equation :

$$Y = Y_0 + d(1 - 10^{-KX})$$

This is an exponential response curve. This curve is characterised by a maximum limiting response d; where Y_0 is the control yield without any fertiliser, K is a constant for each fertiliser measuring the curvature of the response curve, Y and X are the total yield and the amount of fertiliser respectively. Such curves are frequently used in U.K. and other European countries.

(ii) Quadratic Curve :

$$Y = a + b^x + c^{x^2}$$

Here 'a' bears the same meaning as that of Y_0 in Michterlich Equation. 'b' and 'c' are constants. For satisfying the principle of diminising returns $\partial^2 y / \partial x^2 = 2c$ should be ultimately negative, i.e. c must have negative value, otherwise the curve will signify an increasing return. A Quadratic curve is easy to fit and admits data showing an actual decline with heavy fertiliser doses, which is not the case with Michterlich curve.

(iii) Square - Root Formula :

$$Y - a = b x + c^x$$

(iv) $$\frac{1}{Y} = a + \frac{b}{x + c}$$

(v) $$Y = a^{x^m}$$

(vi) Linear Relationship :

$$Y = mX$$

Recent work on the results of field experiments

conducted over years together at the same field under similar conditions have indicated the grounds for assuming a linear relationship upto a maximum point with a sharp transition to a linear and almost horizontal or declining part of the response curve. Experiments at Rothamsted as reported by Cooke and observations of Boyd do indicate the existence of a linear relationship of nitrogenous fertilisers to various crops like sugar beet, cereals, grass, etc. However, under tropical conditions the linear relationship does not hold for long.

Crop fertiliser response study is made more complex by the phenomenon of interaction between fertiliser inputs as already stated. Response to a particular dose of one input depends on the presence of different amounts of other inputs. Thus the effect of factors A and B tested together will not be equal to the sum of effects of same factors A and B tested separately, even with other factors remaining the same. This is known as interaction between inputs. Obviously, for such cases, use of single

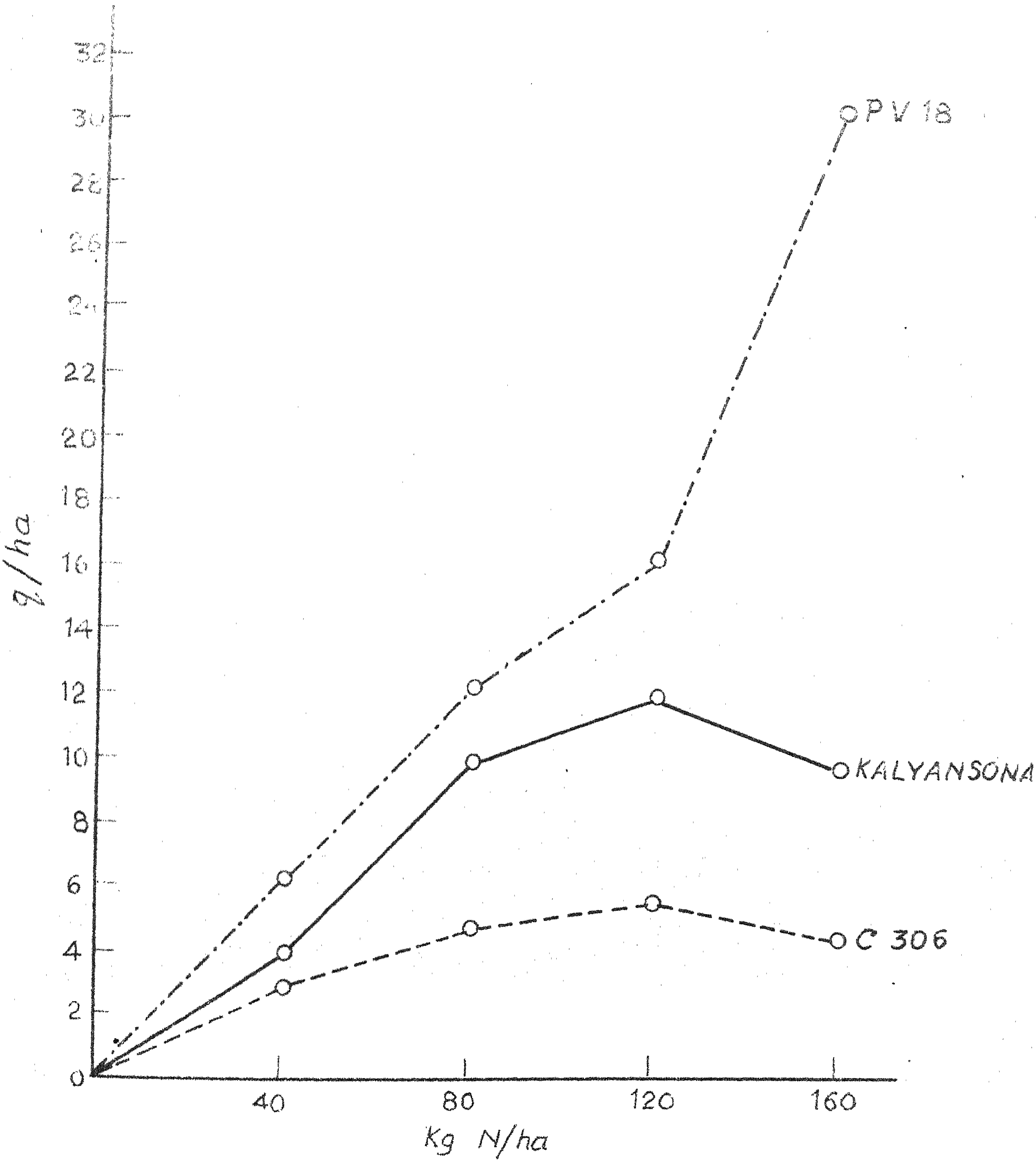


Fig.5.8 Response curves to nitrogen for three varieties of wheat

factor response curves become insufficient and Multifactor Response Surface analysis have to be made for finding out necessary information relating yield with simultaneous variations in the levels of various fertilisers.

The data for the present study are confined to a single response, i.e., of the fertiliser N to H.Y.V. wheat obtained as in the graph below(Fig.53) from the trials conducted by the Haryana Agricultural University, Hissar on farmers' fields under ordinary- as opposed to test- conditions. The response is set out in the following table, where X stands for fertiliser Nitrogen applied and Y for the resulting output of wheat for the cultivar Kalyan Sona.

Table

X Kg/ha	X in 40 Kg. units	Y Q/ha	Y 2 Q units
40	1	4	2
80	2	10	5
120	3	12	6
160	4	10	5

From the above we find that the response to Nitrogen at first rises at a rising rate, then there is a point of inflection and it them rises at a falling rate until a maximum is reached, after which the response actually falls. This is not visible in the cultivar PV 18 in the above graph, because the response beyond 160 kg/ha is not recorded but the expectation is that, as in Kalyan Sona, higher doses would give an increase at a falling rate till a maximum was reached after which the response would record a fall. According to G.Mathur(op. cit) this part of the curve is classed at a set of inferior processes because a higher physical input actually leads to a lesser physical output than at the maximum(designated by Mathur as the 'summit point')[1]. Such inferior processes should obviously not be used, but may be depicted to show the absurdity of using them. In fact experience forces us to acknowledge that sometimes farmers do behave in thir type of irrational fashion.

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1. cf A.K.Sen: Choice of Technique P28 Diagram 2A and G.Mathur, Op cit., P142 footnote 2. Inferior techniques are shown to the right of the summit point.

As we have already noted the traditional curves fitted to response functions are unsatisfactory. This is so for two major reasons.

1) They represent all the techniques available including the inferior once, and that is why the curve fitting takes placed with reference to the whole set of scatter points. In a planning situation we are not interested in options which are not the best. Hence the techniques ought to represent the practices of only the most efficient class of farmers, who should be emulated. Hence the curve fitted should be based upon the behaviour of the top decile or so of farmers, rather than that of the average farmer.

2) The curves are usually fitted to a function which is represented by :

$$Q = AL^{\alpha} F^{1-\alpha}$$

where Q is the quantity of output, L is the quantity of the input land and F is the quantity of the fertiliser input.

This can be reduced to:

$$\frac{O}{L} = \frac{A.\ F^{1-\alpha}}{L^{1-\alpha}}$$

$$\text{or } \frac{O}{L} = A.\left[\frac{F}{L}\right]^{1-\alpha}$$

This curve which is usually referrred to as the Cobb-Douglas function has the property that it is a power-fumstion with a fractional index. Such a curve rises but it is concave to the X-axis. It has no summit point, because its first derivative is always positive. The second derivative of this curve falls quickly at first and slowly later on, that is, it is convex to the origin. This is equivalent to the assumption that diminising returns are absent[2].

Nature implies in all its processes, an ultimate diminishing return and hence a curve which is unable to exhibit this property is basically unsuited to the depiction of responses to inputs. It is for this purpose that either

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2. G.Mathur(Op.cit) P.328

the Cobb-Douglas function has to be amended or rejected.

Gautam Mathur in his depictions, being aware of this defect of the Coff-Douglas, has taken forms which reach a summit point and where the 2nd derivative declines slowly at first and rapidly thereafter, i.e. the second derivative curve is concave to the origin. But Gautam Mathur is concerned with choice of techniques and not the response to individual inputs. Hence there are two aspects of a natural response missing from the depiction. (i) increasing returns in the beginning and (ii) the ultimately rapidly decreasing returns which would make output actually decline when the quantity of input is larger than the one required for the summit point. Hence these two qualities must be incorporated in the extremes of a proper response curve. Not only in physical systems are these abundantly found in nature but the data available to me also shows these properties, as can be seen by looking at the response curve for Kalyan Sona (above Figure

which I consider representative of this type of response.

If these properties are to be incorporated, we should have a function with a term which at small values of input shows a rapidly rising response, at large values a slowly rising response and at very large values on actually falling response. This is obtained by using a two-part function — one term a power series which should have an index not fractional but larger than one (to give a steep rise), and another part an exponential with a negative argument(to take account of the dampening of the response in an increasing fashion as inputs are increased). The second function ultimately becomes more powerful than the first, hence the dampening ultimately leads to a fall in value. This curve represents all the properties I have considered necessary for a response curve for economic analysis. Its general form would be

$Y = Ax^{\beta} e^{-\alpha x}$ where $\beta > 1$ and α is +ive. When fitted to the curve for Kalyan Sona above,

this becomes $Y = 4.25\, x^{2.5}\, e^{-0.8x}$

This produces a curve where there is a cusp near the origin- an increasing response to fertiliser when small doses of N are applied. Subsequently, the marginal productivity declines until the saturation point is reached, which we have here designated the summit point.

It is quite easy, of course, to explain the decline in yield response as input of fertiliser goes up since we are dealing with the ability or inability of a particular cultivar to use soil N effectively. It is fairly well-known that the ability to utilise soil N effectively is much greater in the new hybrid wheat and rice than in the local varieties. But even here there comes a point at which more fertiliser is wasted. What is more intriguing is the implication of the area of increasing marginal productivity of fertiliser input, as shown by the curve near the origin. This is

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Schedule for above; x in 40 kg units, y in 20 units

$A = 4.25$
$\beta = 2.5$
$\alpha = 0.8$

x	y	y	
1	2	1.9	- 0.1
2	5	4.9	- 0.1
3	6	6.1	+ 0.1
4	5	5.4	+ 0.4

almost the shape of a text-book total product curve. Yet, we usually assume that since there is some natural soil fertility, the increasing return portion of the curve should not normally be significant for artificial fertilisers. Field experience of farmers confirm both the points of inflection on the curve. The phenomenon of lodging with ultra-high doses of fertiliser is well-known. But even the cusp at the origin of the curve appears to be within the perception of the farmers.

Time and again in the interviews, a number of them insisted that unless they had access to a minimum amount of N fertiliser per hectare - usually about 40 kgs. per hectare of N - they preferred not to use artificial fertiliser at all. It may be suggested that this is, in fact, not rational because whatever fertiliser they got they could concentrate on a small portion of their holdings instead of spreading it around the holding of 4/6 hectares. This will presumably give them better yield rather than if they went without fertilisers at all. As far as one can see, this kind of choice would be open to large farms where a number of

crops could perhaps be grown simultaneously. It would obviously be uneconomical in a 4-hectare farm with family labour because it would require the farmers to produce with two different technologies each of which would apply to perhaps one or two hectares. Of course, since family labour is not fully utilised except at peak period and the choice of sowing and harvesting period is quite wide, the constraint is basically organisational.

Certain aspects of the behaviour of the farmers should be noted in this context. In the villages in which interviews took place, farming is just changing from traditional subsistence which takes care of the farmers' livlihood at a low level to commercial farming in which profit and loss calculations dominate. Obviously in the subsistence farming, the farmer kept down his investment to a minimum so as not to risk loss and the labour of his family having no alternative use and no opportunity cost attached to it. Consequently, there was little choice in the resources or efforts that went into farming operations. Even now the marginal farmers, whom we have not considered

in this study, operate at this minimum level. The farmers who were interviewed however, have already changed to commercial agriculture and several levels of investment are considered by them. This factor will be shown in more details in a subsequent chapter of this study entitled 'Optimum Choice of Technique'. Here, it is sufficient to identify those factors which enter into their calculations about fertiliser use.

The object is to find out why the farmers routinely use much smaller doses of fertilisers than that recommended in the Package of Practices so carefully circulated to them by the Government of Haryana.

It is a valid generalisation that the higher the investment per unit in a given environment, the greater is the risk per rupee invested and this relation probably persists exponentially. With higher levels of fertiliser usage the input package increases correspondingly causing more problems of balancing and co-ordination and impinging on the administrative environment which is barely

enough now to sustain a very high level of individual farm investment.

As we have noted the marginal net return to the farmer is the joint function of the cost of inputs and the price of output as realised by the farmer. Hence the actual rate of return position is to be de-valued in a number of ways. The expectation of marginal net return of the individual farmer, i.e. his perception of the risk involved is more important than the actual realisation of the marginal return of his investment. Since he operates from a low credit and income base, a negative return or even low return for a very small number of farmers impresses him more than a high return for the majority. In averaging our statistics, we tend to overlook this factor. What are the factors which determine the farmers decision to invest a specified proportion in fertilisers relative to the optimum dose in a specified environment ?

(i) The "return-on-investment" schedule with different fertiliser doses or what may be called the crude cost-benefit ratio.

(2) The availability of matching inputs-a quantified probability index as framed in the farmer's mind including the farmer's expectation of the answer, synchronising with input elements in the package of agronomic practices.

(3) The confidence of the farmers regarding the appropriate implementability of the new technology in his own farm. This will be influenced by his perception of the (a) merit of the technology itself and (b) on the ability of himself and the environment to translate the technology effectively to his own desired level of benefit. As to (a) above, disappointment usually arises from unduly standardised recommendations and as to (b) from the great deal of detail and intervariability with which the inputs have to be applied, not to speak of the gap between paper extension services and actual service in the field.

(4) Natural forces - Lack of environmental control, adverse ecology and technological failures of prescriptions and applications.

(5) Administrative failures which in the new technology is only too likely since it involves

a large amount of co-ordination and attention to detail.

(6) Uncertainty as to the ultimate harvest and the assurance of appropriate price: access of small and marginal farmers to markets and mundis where fair price is ruling is still not adequate, and they sometimes get only 50 per cent to 60 per cent of the procurement price.

Under the above circumstances, the farmer is prone to play safe and often uses fertiliser far below the economical optimum in any good environment. To ensure that he applies fertilisers according to the crop response function, here delineated, supportive policies have to be followed which we have discussed in our conclusions.

TABLE 5.1

Nitrogen requirement for specified wheat yield levels under different rotations.

Rotations *	Nitrogen required in Kg/ha for different yield levels			
	25 q/ha	30 q/ha	35 q/ha	40 q/ha
1. Fallow(uncultivated)-wheat	36.2 (98)	51.2 (98)	69.8 (98)	98.4 (98)
2. Cowpea grain(UF)-wheat	7.7 (21)	19.8 (38)	34.1 (48)	52.4 (53)
3. Cowpea grain(F)-wheat	2.2 (6)	13.7 (26)	26.9 (38)	43.0 (43)
4. Mung(UF)- wheat	18.9 (51)	27.3 (52)	44.1 (62)	61.5 (62)
5. Mung(F)- wheat	16.7 (45)	29.4 (56)	44.5 (63)	64.3 (65)
6. Sorghum fodder(F)-wheat	36.8 (100)	52.0 (100)	70.8 (100)	99.2 (100)
7. Cowpea fodder(UF)- wheat	15.7 (43)	28.1 (52)	41.0 (58)	60.0 (60)
8. Cowpea fodder(F) - wheat	13.9 (38)	25.1 (48)	38.4 (54)	56.2 (57)

* F and UF indicate fertilised and unfertilised crops respectively. Figures in parenthesis are indexes with nitrogen required under sorghum fodder(F) - wheat rotation as base.

Source : Fertiliser News, May 1977; Page 35.

TABLE 5.2

Maize yield with different preparatory tillage

Tillage system	Annual Fertiliser rate(kg/ha) N	P	K	Maize yield (kg/ha) Average for 3 years
Zero Tillage	224	0	0	6026
-Do-	224	51.5	93	7135
Chisel plow	224	51.5	93	7554
Conventional	224	51.5	93	6010
L.S.D. 5 per cent				628
				12 per cent

Source: By Sekhon & Khelon(FAI & FAO Seminar on Strategy for Stimulating Fertiliser Consumption 1976)- Page - 1-2/2.

TABLE 5.3

Method of sowing and wheat yield.

Treatment	Grain yield(q/ha)
1. Sowing with a cultivator	55.5
2. Sowing with a seed drill	61.1
3. Sowing with a seed drill having a pack wheel	69.0

Source: By Sekhon & Kehlon(FAI & FAO Seminar on Strategy for Stimulating Fertiliser Consumption 1976)-Page 1-2/4.

TABLE 5.4

Economic Analysis of Nitrogeneous Manuring of High Yielding varieties wheat at constrat prices of input and output.

Particulars	Unit	Kalyansona	Sonalike	Hira
Optimum dose	$kg.ha^{-1}$	123.99	131.07	134.14
Expected yield at the optimum	$kg.ha^{-1}$	5982.94	5143.99	5318.59
Gross return at the optimum	$Rs.ha^{-1}$	4547.03	3909.43	4042.13
Response yield at the optimum	$Kg.ha^{-1}$	2014.62	1236.08	1147.11
Gross profit at the optimum	$Rs.ha^{-1}$	1531.11	939.40	871.80
Cost of optimum input	$Rs.ha^{-1}$	307.57	324.57	331.94
Net profit at the optimum	$Rs.ha^{-1}$	1223.54	614.83	539.86
Net profit per Kg.N at the optimum	Rs.	9.87	4.69	4.09
Input out-put ratio	-	1:14.78	1:12:04	1:12.18
Net profit per rupee spent on the dose	Rs.	3.98	1.89	1.63
Efficiency of Nitrogen application at the optimum	-	16.24	9.45	8.55

Source: Agricultural Situation in India by Directorate of Economics & Statistics, Ministry of Agriculture & Irrigation, Government of India Publication, May 1977.

Page: 71.

TABLE 5.5.

Average responses (kg/ha) of different crops to fertiliser treatments in different regions of India.

Crops	Region/State	N_{60}	N_{120}	$N_{40}P_{30}$	$N_{120}P_{60}$	Response to P_{30} over N_{60}		Response to P_{60} to N_{120}	
						Total	Profit per hect.	Total	Profit per hect.
1. Rice kharif (Irrigated)	1. Northern Haryana, U.P.	775	1308	957	1822	182	-46.50	514	19.50
	2. Overall regions.	748	1253	1155	1961	407	122.25	728	180.20
2. Wheat	1. Northern (Delhi, Haryana, Punjab)	769	1320	1275	2237	506	373.60	911	636.10
	2. Indo-Gangetic (Hissar, UP)	810	1318	1060	1790	250	92.00	472	153.20
	3. Overall Regions	695	1162	1072	1840	377	231.70	778	489.20

Source: FAI-FAO Seminar on Strategy for stimulating Fertiliser Consumption, 1976 by A.S. Kahlon and G.S. Sekhon - Page III-1(ii)/6.

TABLE 56

Response of crops to fertiliser phosphorus in different cropping sequences

Crop	Cropping-sequence	Place	Crop response to fertiliser phosphorous (kg.grain/kg P_2O_5					
			Direct	Residual	Cumulative	Direct	Residual	Cumulative
			(30 kg. P_2O_5/ha)			(60kg. P_2O_5/ha)		
Maize	Maize-wheat	Ludhiana	18.8	10.3	13.9	5.3	7.6	2.9
Bajra	Bajra-wheat	Hissar	8.9	3.1	7.9	7.4	5.5	7.4
	Maize-wheat	Ludhiana	36.3	32.6	42.2	25.6	26.7	27.1
	Bajra-wheat	Hissar	19.8	12.9	16.1	17.0	13.8	13.2

Source: By Sekhon & Khelon(FAI-FAO Seminar on Strategy for Stimulating Fertiliser Consumption, 1976)

Page : 1-2/12.

TABLE 57

Estimated average annual fertiliser consumption per hectare and yield of rice in some selected States of India (1971-72 to 1974-75)

State	Area (million hectares)	Irrigated area (per cent)	Fertiliser consumption				Yield of rice kg/ha	Response in kg/ha of nutrient(rice)
			N	P_2O_5	K_2O	TOTAL		
Uttar Pradesh	4.51	10	6.7	0.9	0.7	8.3	797	
Punjab	0.50	92	72.0	6.0	4.0	82.0	2104	13.6
Haryana	0.29	90	48.3	6.9	3.4	58.6	1680	10.5

Source: By Sekhon & Khelon(FAI & FAO Seminar on Strategy for Stimulating Fertiliser Consumption 1976).

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TABLE 5.8

Estimated average fertiliser consumption per hectare and yield of wheat in some selected States (1971-72 to 1974-75)

State	Area	Irrigated area (million hectares)	Fertiliser consumption (kg/ha) N	P_2O_5	K_2O	TOTAL	Yield kg/ha	Response in kg/ha of nutrient
Uttar Pradesh	6.05	4.14	21.8	5.3	3.6	30.7	1148	5.6
Punjab	2.35	2.07	58.3	18.7	4.7	81.7	2307	15.4
Haryana	1.19	1.00	38.8	4.2	1.8	44.8	1770	15.4 (12.3 excluding 1971-72)

Source: By Sekhon & Khelon (FAI & FAO Seminar on Strategy for Stimulating-Fertiliser Consumption 1976)

Page I-3/5

TABLE 5.9

Plant population, maize yields and fertiliser nitrogen efficiency

Particulars	Plant population ('000 plants per hectare)			
	20	40	60	80
Crop yield without nitrogen(q/ha)	11.1	15.5	17.4	12.8
Crop yield with 160 kg.N(q/ha)	30.2	42.1	49.7	35.4
Nitrogen efficiency kg.grains/Kg.N	11.9	16.6	20.2	14.1

Source: By Sekhon & Khelon(FAI & FAO Seminar on Strategy for Stimulating Fertiliser Consumption 1976)- Page 1-2/5.

TABLE 5.10

Response of High yielding and all varieties of wheat to fertilisers.

Particulars	Tall varieties	High yielding varieties
Yield without fertiliser(kg/ha)	1650	1988
Response to nitrogen (kg grains/kg.N)		
1st 60 kg. N	8.3	11.6
Subsequent 60 Kg. N	4.7	9.8
Response to phosphorous (kg.grains/kg.P_2O_5)		
30 kg.P_2O_5 over 60 kg. N	8.6	12.6
60 kg.P_2O_5 over 120 kg.N	7.8	11.3
Response to Potassium (kg.grains/kg.K_2O)		
60 kg.K_2O over 120 kg. N + 60 kg.P_2O_5	2.6	3.3

Source: By Sekhon & Kehlon(FAI & FAO Seminar on Strategy for Stimulating Fertiliser Consumption 1976)- Page 1-2/2.

VI

OPTIMUM CHOICE OF TECHNIQUE

6.1 This study will compare the cost of production and profitability of small, medium and large farms using the cropping package recommended for each soil climatic region by the extension Department of Haryana Agricultural University, Hissar. It should be noted that this implies that we shall not attempt to fit a production function to an ordinary scatter diagram which depicts average productivity of farms. By choosing the recommended package we are adopting the best techniques, not the average of all customary technique.

6.2 There are number of ways of identifying the size of farms:

(1) Size of operational holdings: This is the simplest criterion that can be used;

(2) Both net income and gross output criteria can be used under traditional and improved technology.

(a) Gross output. The gross value of output worth Rs.2,400/- per annum is

usually considered as the measure for identifying small farms. Thus under traditional methods of cultivation, an area of less than 3½ hectares is usually considered a small farm.

(b) Net farm income: Net farm income is usually calculated by deducting costs of items which are actually paid out from the value of gross output.

(3) Organisation of the farm - for instance ratio of family labour to hired labour.

(4) Degree of integration -the extent of inter-dependence between the farm and its environment, e.g. amount of production sold as compared with internally consumed production.

6.3 Obviously, no single criterion is adequate. The definition detailed below is similar to that used in series published in the 'Studies in Economics of Farming in Haryana'. This agrees with the S.F.D.A.

classification also.

6.4. Somewhat modifying the pattern used by the Government of Haryana in its studies in the Economics of Farming series, we can distinguish three types of cost situation corresponding to 3 degrees of capital intensity.

i) The first type is large commercial farms, 10 hectares or more comprising 8.12 per cent of the total number holdings amounting to 34.18 per cent of the total area of all operational holdings. The average size of holdings of this type is 15.7 hectares (Ref. Census of Agricultural Holdings in Haryana State, 1970-71). We will assume that production will be managed commercially i.e. it will include hired labour, tractors and pumps for irrigation etc.

ii) The second group will comprise of holdings between 5 and 10 hectares. This includes 16.24 per cent of the total number of holdings. The costs of this

group will be calculated assuming family labour supplemented by the occasional casual labourers. The capital involved will be assumed to include bullocks, iron ploughs and small modern implements with cost of canal irrigation but without the use of the farmers' own pump sets.

iii) The third group will comprise of size between 5 and 2 hectares and 19.79 per cent of the total holdings. The technology used will be confined to completely traditional, i.e. wooden ploughs, bullock pairs and family labour. The cost of irrigation will be shown separately again as canal irrigation.

6.5. Here, we are not considering a large number i.e. 29.3 per cent of the total cultivators in the State who are small and marginal farmers with holdings of less than 1 hectare of cultivable land, as, in their present form, these holdings

are not viable, leaving both human and bullock labour largely unutilised. In the search for an optimum these holdings are clearly not to be considered.

6.6 The prices of inputs have been calculated as follows. For reasons stated later we have not included the value of land. However some indications are available from the assessment made by a Land Valuation Officer of primary Land Development Bank for purposes of a loan application. For the purpose of hypothecation, the Primary Land Development Bank divide land values into three groups:

(1) Un-irrigated (Barani)

(2) Canal Irrigated (Nehri)

(3) Well irrigated (Chahi) and values are fixed for each Tehsil separately.

6.7 Since we shall be concerned here with the use of fertiliser, we would have considered only irrigated land suitable for High Yielding Varieties of seeds and not 'Barani' land. The value of Nehri varies from Rs.7,000/-per hectares at the lowest

The price of Chahi varies from Rs.7,500/-at its lowest (Hansi, Jagadhri) to Rs.11,250/- at its highest (Ballabgarh). Accordingly, the mean value is roughly Rs.10,000/-.

6.8 The value of a pair of bullocks is estimated at Rs.9,300/-. The average maintenance cost varies between Rs.1,971.68 (highest (Jind, Rohtak- Sonepat region) to Rs. 1296.31 lowest (Ambala-Karnal-Kurukshetra region) being the estimates to be found in Farm Budget Studies from the years 1970-71 to 1975-76. The labour cost of upkeep has been kept lower than the market wages since bullocks are usually looked after by family labour. The average payment to permanent workers has been going up slowly and was Rs.1379.90 in 1973-74. It should be noted that this is an average and it does not reflect the fairly sharp divergence between wage rates in different areas nor does it include the cost of free meals at the market rate. It is difficult to determine the latter as the permanent worker has his meals with the family out of the current farm-produce. The average wage rate for casual work was about Rs.5.57 per day to Rs.5.94 per day in the slack season to Rs.6.99 to Rs.7.29

per day in the busy season. In areas close to cities specially Delhi and Faridabad, the seasonal variation is naturally much less. However, there is real shortage of labour in the peak season and daily wages may even go up to Rs.10/-occasionally. In my interviews, the farmers often gave higher figures for wages especially of the permanent workers. Equally, the agriculture labourers when asked separately tended to give very much lower figure. The custom of paying a portion of the produce in kind in lieu of wages also makes assessment of accurate figures difficult. While it is difficult to be sure, it appears that, on the whole, permanent workers' condition of labour and rates of wages have risen. However, the casual labourer specially in districts like Hissar and Bhiwani, for lack of adequate alternative employment, probably does not get even Rs.5/- a day in the slack season.

6.9 The average cropped area per permanent worker worked out to about 3.8 hectares and he is said to have worked for 245 days in the year at about 5.4 hours a day. The average cropped area per pair of bullocks was about 8.21 hectares and 164 days were

worked out at 3.6 hours a day. However, for the purpose of our calculation, we will be using 8 hours a day. The area which we are most interested in, viz. Ambala, Kurukshetra and Karnal region had greater use of both types of labour than the average for Haryana. The average investment per hectare on implements has been going up sharply in the case of non-traditional technology and was about Rs.790/- per hectare in 1973-74. The implements here considered include those which are used with tractors as well as others like seed drills which are used on their own. It should be noted that in the case of first two categories of farms, manual labour and bullock labour were the major constituents of farm expenditure and if we were to add rent of land they would together form about three fourths of the total cost of cultivation.

6.10 Besides hired labour, herdsman, blacksmith and carpenters are also engaged by the farmers. The herdsmen charge between Rs.3 to Rs.4 per cow or buffalow per month. The blacksmith or carpenter is usually engaged on an annual contract system, the rates of which are fixed for each village on the basis

of number of ploughs and pairs of bullocks. This item is of importance to the small farms for the maintenance of farm implements. However, I have also included them in the larger farms because invariably a pair of bullocks are kept for pulling of carts and other minor agricultural activities.

6.11 In Haryana the average gross income per hectare operated according to 1973-74 figures, was Rs.3218.80 on irrigated land and Rs.1357 on un-irrigated land. It should be noted, however, that there was considerable difference between the cost of production which was naturally much higher in the irrigated land. The output prices used in the calculations are farm harvest prices, while input prices like that of fertiliser are ordinary retail prices. This may lead to some difficulties because the farmers who live fartheraway from the distribution points pay much more for their supply of fertiliser. However, it seemed unnecessary to refine too much upon this for what is purely an illustrative study.

6.12 It is interesting to note that while the price of all foodgrains has risen steadily from

1956-57 to the present with a sharp increase in 1973-74 in the price of rice (from Rs.57.32 per quintal to Rs.73.92 per quintal) the price of wheat fluctuated widely falling sharply after the Green Revolution to a price of Rs.75 per Q. going up with a spurt in 1973-74 to Rs.120/- per/Q and falling the very next year to Rs.108 per/Q. It would be preferable to use the procurement price of rice and wheat rather than harvest price. However, the farmers' decisions as to the use of technology are dominated by harvest prices and therefore this seemed to be more appropriate.

6.13 On the question of mechanisation a few empirical findings may be relevant. In a study undertaken by the Economic and Statistical Organisation of the Government of Haryana at the request of Registrar, Co-operative Societies, Haryana, the socio-economic condition of farmers, who purchased the tractors was looked into. The data related to 21 holdings in the district of Karnal. Their size varied from 6.47 to 40.47 ~~xxxxx~~ hectares. These farmers have been advanced loans during 1966-67

for the purchase of tractors and a follow-up study was made in 1970. Unfortunately, most of the farmers did not maintain any farm accounts so that the relevant information was collected only in respect of one or two years before the purchase of the tractor. Only 3 farms were completely mechanised since in addition to the tractor, each farmer also maintained one or two pairs of bullocks. This is partly due to the fact that some minor agricultural functions are more efficiently handled by bullocks and partly because the bullocks were always available even when the machine had gone out of order. Specifically, the bullocks serve as a complementary draught power for ploughing, for working of the persian wheel, haulage of bullock-carts etc.. The cost accounts of the farmers, therefore, include at least one pair of bullocks.

6.14 Two interesting institutional features emerged from the study on tractor use referred to above. First, that some of the lessees had pooled their resources for the purchase of a tractor and were carrying on joint cultivation of their land. Secondly, a number of cultivators were carrying on

regular business of sale and purchase of tractors without actually using them for their cultivation. The implications are that there is a considerable scope for renting out the tractors and implements in order to bring the small farmers within the ambit of modern technology. In the context of the present study, this means that the demand for fertiliser depending, as it does, on the intensity of cultivation as well as on the availability of water can be expected to go up with appropriate Government policy in semi-arid regions. As will be evident from later paragraphs however, use of tractors is not recommended for other regions, as the returns to tractor use are much lower than to traditional technology.

6.15 Among the farm implements used by the cultivators are tractors with accessories fodders, a chaff cutters, ploughs, iron crushers threshers, seed drills, furrow turning ploughs, carts with pneumatic tyres, etc. If we take the life of the average tractor and accessories to be roughly 8 years or more the cost should be adjusted as in a smaller holding the life of the tractor will be somewhat longer.

6.16 The large farms have been found to have considerable economy of scale. The technology of the Green Revolution is neutral with respect to the size of farms, at least for farms about two hectares to 2.5 hectares, in that the response to High Yielding Varieties of seeds with appropriate fertiliser and irrigation water is good and farm operations usually manage to utilise family labour reasonably and adequately, but this does not imply that larger farms will not enjoy economies of scale in other directions.

6.17 It has been found, for instance, that with bullock power, it is impossible to achieve a cropping intensity of more than 140 per cent. More than this figure is uneconomical as a great deal of land has to be released for purposes of maintenance if fodder is not to be bought. The tractors can be used by the larger farms can raise the intensity of cropping to as much as 200 per cent and, in fact, can make it possible to cultivate the land continuously. Therefore, in the cost calculation, in Table annexed at the end of this Chapter, the intensity of cultivation for the 5 hectares farm has been shown as 145 per cent while that of 10 hectares farm has been shown as 180 per cent. On the

other hand, we recognise that in a small farm intensive use of human and bullock labour is possible. Consequently in the 2½ hectares farm we have shown a cropping intensity of 200 per cent.

6.18 There is also a problem of chronic labour shortage during the typical peak period which synchronise with the harvesting of wheat, planting of rice, harvesting of maize and Bajra and picking of cotton. The ideal sowing time for High Yielding Varieties of wheat is from the last week of October to the first week of November. This means that Kharif paddy must be harvested very fast - (and the wheat- rice rotation gives the highest returns to cash investment). During this period, labour rates are a minimum of Rs. 10 per day exclusive of meals which are provided by the farmers. The labour wage rates have more than doubled during the last few years but even at this high wage rate there non-availability of labour at times of peak requirement which make it physically difficult for the farmers to go in for multiple cropping and increase cropping intensity in general. Though 90 per cent of labour requirement are met from within the family, it is estimated that with the rise of education and increased employment opportunities, the quantum of

available agricultural labour force has been decreasing during the last decade.

6.19 Investigations into the cost of cultivation have shown that the cost of labour both manual and bullock labour amounts to 63 per cent of the total cost. In the case of irrigated crops, the bullock pair represents roughly 50 per cent of the total labour cost.

6.20 In the case of dry farmed areas the preparation of land must take place very fast in order to take advantage of seasonal rain which is very or quite erratic. While this is possible in the case of tractors, human and bullock labour are unable to work fast enough. Similar problems arise in the need for quick harvesting of crops. For all these reasons, the number of tractors grew in Haryana by a factor of three in the decade of sixties, mainly in the last three years, i.e. 1967 to 1970.

6.21 The illustrative cost calculations worked out in Tables 6.1-6.3 have been converted in terms of a production locus in order to compare the rates of

return of investment from the three scales of operation and three technologies represented respectively as follows:

(1) The superior technology employed on the 10 hectares farm designated

(2) The intermediate technology employed on the 5 hectares farm as designated

(3) The traditional technology with adjustments only for fertiliser use is designated

6.22 We have not considered the value of land because sociologically speaking land is not looked upon as an investment option but rather as status symbol, in other words it is not contemplated that because the return to land will be lower, the man will sell his land and will put the money into industry. In Haryana at least this situation does not prevail,one reason why even the marginal farmer will not alienate his land. Indeed, the extent of land hunger shown by the fact that the market price is double or more double, the figure calculated by Primary Land Development Banks and has no conceivable connection with economic return expected from it. Interest on loans has also not been considered.

Following the technique used by Dr. Gautam Mathur, in his book "Planning for Steady Growth", we wish to work out the relationship between the fixed and working capital i.e. the organic composition of capital and, therefore, it is more convenient to assume that fixed capital is owned rather than hired. In order to get the ratio of output and capital to labour, we have added permanent and temporary labour by counting 300 days of casual labour as one full worker. We have then divided the total wage cost by the number of workers so calculated in order to get L as depicted in the graph below. The calculations of profit in terms of labour units and in terms of prime cost are set out in the two graphs and tables given below

Table 6.1

Technique α

ILLUSTRATIVE

FARM BUDGET OF A TEN HECTARE IRRIGATED HOLDING OPERATED BY TRACTORS IN NORTH-EASTERN DISTRICTS OF HARYANA (KARNAL-AMBALA).

Cropping Pattern	Area in hectare	Yield in Qtl. per hectare	Total product in Qtl.	Price per Qtl. in (Rs.)	INCOME Gross Output value in (Rs.)
Kharif					
Sugarcane	1.25	700.00	875.00	8.00	7000.00
Paddy	5.30	31.00	164.30	80.00	13144/00
Maize	0.65	31.00	20.15	80.00	1612/00
Cotton (Amr)	0.00	-	-	-	-
Cotton (Desi)	0.45	10.00	4.50	200.00	900/00
Fodder	0.75	-	-	-	-
Sub Total	8.40				22656/00
Zaid Rabi					
Toria	1.00	8.00	8.00	160/-	1280/-
Potato	0.60	220.00	132.00	60/-	7920/-
Sub Total	1.60				9200/-
Rabi					
Wheat	8.00	36.00	288.00	105/-	30240/-
Gram	0.20	9.00	1.80	147/-	264/60
Fodder	0.40	-	-	-	-
Barley	0.00	-	-	-	-
Sub Total	8.60				30504/60
GRAND TOTAL	18.60				62360/60

Intensity of cropping: 186%

Item of expenses	EXPENDITURE Cost
1. Labour 3 workers @ Rs.1380/- per annum	4140/-
2. Casual labour 60 days per Hct. @ Rs.7/- per day +food	6510/-
3. Seed cost	2300/-
4. Fertilisers	5000/-
5. Plant protection	800/-
6. Implements & artisans @ 45/- per hct.	255/-
7. Irrigation expenses (cost of unit of electricity)	1100/-
8. Land revenue	150/-
9. Tractor & implements value-	
a) Depreciation at 12%	2600/-
b) Operational expenses per hour @ Rs.5/40 per 975 hours	4072/-
c) Taxes & insurance	280/-
10. Bullock labour	1236.31
Gross expenses	30390.31

Net value of production (Rs.): 62360/60 - 30,390.31 = [illegible]

Table 6.2

Technique β

ILLUSTRATIVE

FARM BUDGET OF A FIVE HECTARE IRRIGATED HOLDING OPERATED BY BULLOCKS IN NORTH-EASTERN DISTRICTS OF HARYANA (KARNAL-AMBALA).

Cropping pattern.	Area in hectare	Yield in qtl. per hct.	Total products qtls.	Price per qtls. (Rs.)	INCOME Gross output value (Rs.)
Kharif					
Sugarcane	0.40	675.00	270.00	8.00	2160/-
Paddy	1.80	[illegible].00	45.00	80.00	3600/-
Maize	0.40	28.00	11.20	80.00	896.00
Cotton (Amr)	0.00	-	-	-	-
Cotton (Desi)	0.10	8.00	0.80	200.00	160.00
Fodder	1.00	-	-	-	-
Sub Total	3.40				6816/-
Zaid Rabi					
Toria	0.20	8.00	1.60	160.00	256/-
Potato	0.10	200.00	20.00	60.00	1200/-
Sub Total	0.30				1456/-
Rabi					
Wheat	2.65	30.00	79.50	105.00	8347/50
Gram	0.30	9.00	2.70	147.00	396/90
Fodder	0.60	-	-	-	-
Barley	0.00	-	-	-	-
Sub Total	3.55				8744/40
GRAND TOTAL	7.25				17016/40

Intensity of cropping 145%

Item of expenses	EXPENDITURE Cost
1. Labour 1.1/2 workers @ Rs.1380/- per annum	2070/-
2. Casual Labour 50 days per Hct.@ Rs.7/-per day + food	2537/50
3. Bullock Labour	1296/31
4. Seed cost	370/-
5. Fertilisers	1700/-
6. Plant protection	100/-
7. Implements & artisans' expenses @ Rs.45/- per Hct.	225/-
8. Irrigation expenses (cost of units of electricity)	275/-
9. Land revenue etc.	60/-
Gross expenses	8633/81

Net value of production (Rs.) = 17016/40 - 8633/81 = 8382/59

Table 6.3

Indicus γ

ILLUSTRATIVE

FARM BUDGET OF A 2.1/2 HECTARE IRRIGATED HOLDING OPERATED BY BULLOCKS IN NORTH-EASTERN DISTRICTS OF HARYANA (KARNAL-AMBALA)

Cropping pattern	Area in hectare	Yield in Qtl. per hectare	Total product in Qtl.	Price per Qtl. in (Rs.)	INCOME Gross output value in (Rs.)
Kharif					
Paddy	1.50	30.00	45.00	8.00	340/-
Fodder	1.00	-	-	-	-
Sub Total	2.50				340/-
Zaid Rabi					
Toria	0.20	8.00	1.60	160.00	256/-
Potato	0.10	200.00	20.00	60.00	1200/-
Sub Total	0.30				1456/-
Rabi					
Wheat	1.80	30.00	54.00	105/-	5670/-
Fodder	0.40	-	-	-	-
Sub total	2.20				5670/-
GRAND TOTAL	5.00				7466/-

Intensity of cropping 200%

Item of expenses	**EXPENDITURE** Cost
1. Bullock labour	1236/31
2. Seed	280/-
3. Fertilisers	900/-
4. Plant protection	80/-
5. Implements	110/-
6. Irrigation	140/-
7. Land revenue etc.	30/-
8. Imputed labour (family)	1390/-
Gross expenses	4166/31

Net value of production (Rs.): 7466- 4166/31 = 3299/69

6.23 As we have already pointed out ordinary scatter diagrams and the production functions fitted to them represent average productivity of the farms. The majority of farms quite often use inferior cropping mix, i.e., those which provide lower income with no savings in cost. Such choices are eliminated here. In a situation of planning for development it is the most efficient farms - perhaps the top decile - which are relevant as targets for the rest of the farms to come up to.

6.24 The tables 6.1 – 6.3 give typical farm budgets for the 3 capital intensities chosen. The size, use of equipment and source of power differ. For purpose of comparison they must therefore, be portrayed on normalised 10 hectare farm units. For most items, simple multiplication suffices. There are, however, two exceptions: i) Since the small, i.e., 2.5 hectare farm exclusively uses family labour, and not exhaustively or completely at that, the wage-rate works out marginally lower; ii) Since one bullock pair is quite adequate for 5 ha, the cost of bullock-labour is merely doubled, and not multiplied 4 times for the 2.5 hectare plot.

6.26 The table 6.4 below sets out the standardised costs for 10 hectare holdings using the three techniques previously discussed. The technique using tractors and modern implements and having the highest capital intensity ~~xxx~~ we designate as α ; that using bullocks and traditional but improved implements, and having intermediate capital intensity we designate as β ; the technique using bullock-labour and traditional (unimproved) implements and having the lowest capital intensity is designated γ . It is worth repeating here that for each technique the most efficient choice for that capital intensity is used. Hence H.Y.V. seeds and assured irrigation are assumed.

Table 6.4

Comparison of costs for techniques , and for standard 10 ha. plots:

Item	Symbol	Unit			
Output	O	Rs. thousand	56	34	30
Fixed capital	K	Rs. thousand	50	18.6	18.6
Labour	L	300 working days	6	6	8
Prime cost (Variable cost)	PC	Rs. thousand	30.40	16.76	16.66
Rate of return	$\dfrac{\frac{O}{L} - \frac{PC}{L}}{\frac{K}{L} + \frac{PC}{L}}$	Per cent	32	49	38
Rate of interest (actual)	i	per cent	~~[illegible]~~ 12	~~[illegible]~~ 12	12

Net profit rate	r	per cent	20	37	26
Probable social rate of interest.	i	per cent	16	12	4
Adjusted (social) rate of profit	P	per cent	16	37	34

6.26 Without any further processing of the cost data it becomes obvious that even at the present market rates, the intermediate Technology provides the highest rate of profit and the traditional technology does better than the highly capital intensive technology. If we consider that there is a severe capital constraint in the economy we should, for purposes of planning, use a social rate of interest which penalises capital-intensive technology and subsidises labour-intensive technology. Hence I have also set out a probable value of social interest rate and adjusted the profit-rate accordingly. This shows that there is considerable justification for encouraging the introduction of even the traditional technique at its most efficient by subsidising credit for the purchase of H.Y. seeds and optimum fertiliser as calculated in the previo chapter.

6.27 The table is not, however, analytically

adquate since both the capital stock and numbers of labou[r] units are different for the three techniques. In order t[o] elicit the optimum technique with greater clarity, a production function or locus must be drawn. This is a two-stage process. In the first stage Fig 6.1 product per man $\frac{O}{L}$ in relation to capital per man $\frac{K}{L}$ is depicted for the three techniques. To show clearly the differences of prime costs vis-a-vis fixed equipment, the prime cost is taken on the negative side of the Y-axis. From the origin O a line OB is drawn in the N.W. quadrant at 45° from the Y axis. As a result, a line drawn throug[h] any point on the Y axis and parallel to the X-axis when extended to cut line OB, will measure off a portion on the X axis exactly equivalent to the portion cut off on the Y axis. This will automatically result in additi[on] of all capital costs. By measuring output and prime cos[t] on the Y axis and subtracting prime costs from output, th[e] net surplus over cost is obtained. The ratio of surplus to total capital cost i.e., the rate of profit is thus obtained as the tangent of the angle formed upon line OB which in the figure below is shown as Tan α, Tan β Tan γ as the case may be.

6.28 The diagram described above does not however, visually demonstrate the highest rate of profit on account of the various angles representing the rate of profit being placed at different points on line OB. To obviate this figure is drawn in which the quantities on both X and Y axes are divided by the prime costs. Thus on the Y axis we get the ratio of output to variable costs and on the X axis we get the ratio of fixed to variable costs - which also incidentally represents the organic composition of capital. It may be noted that since we are dividing the output of each technique by its own prime costs the dividend will necessarily be unity. Hence the line parallel to the X-axis upon which the L^s represents profits are formed will start from an identical point on line OB. Hence the visual representation facilitates the identification of the technique with maximum profit. As in the previous Figure 6.1 , the rate of profit again comes out to be the maximum for β technique. However, γ technique is shown here to be almost as good.

6.29 The format of the curve joining γ , β and α is of the nature of a production locus, rather tha

a production function, as already noted. Unlike the usual production function in which valuation of technique is on the basis of a common wage rate for all techniques, the production locus permits difference in the wage rate as between techniques. Wage rates and rate of profit may both differ as techniques depicted are the optimum ones at each wage rate. This is how the difference is depicted in Prof. Gautam Mathur's book "Planning for Steady Growth". In a developing economy, variations in wage rate are expected to be persistent and must be taken account of in any realistic planning situation.

6.30 However, like Mrs. Joan Robinson in her book; The Accumulation of Capital, Gautam Mathur assumes an economy with only two basic factors of production displayed on the production locus i.e., capital and labour. Hence prime costs and wage costs are identical. In any real situation, however, the variable costs include other items besides the labour costs. The methodology of the production locus when adapted for this purpose would not depend upon normalization per wage unit but per unit of prime cost (i.e. all variable costs). This is how the above presentation differs from the theoretical models referred to earlier, and extends the concept of

the production locus to the case where the variable costs include items other than wages. It may be noted here that it is the prime cost which varies in the present formulation and not necessarily the wage rate. The data shows that in the three techniques set out, variable costs are considerably different among the techniques, but the wage rate confronting the farmer is not significantly different.

6.31 From the curve which is obtained on empirical grounds one notices that as the organic composition of capital rises the output in terms of prime cost declines. In the curve as depicted the output in relation to prime cost at first rises sharply and then falls. It would be interesting to investigate further whether there are any conditions under which the theoretical expectation of a monotonically decreasing ratio of output to prime cost would be found to exist, as classical theory predicts.

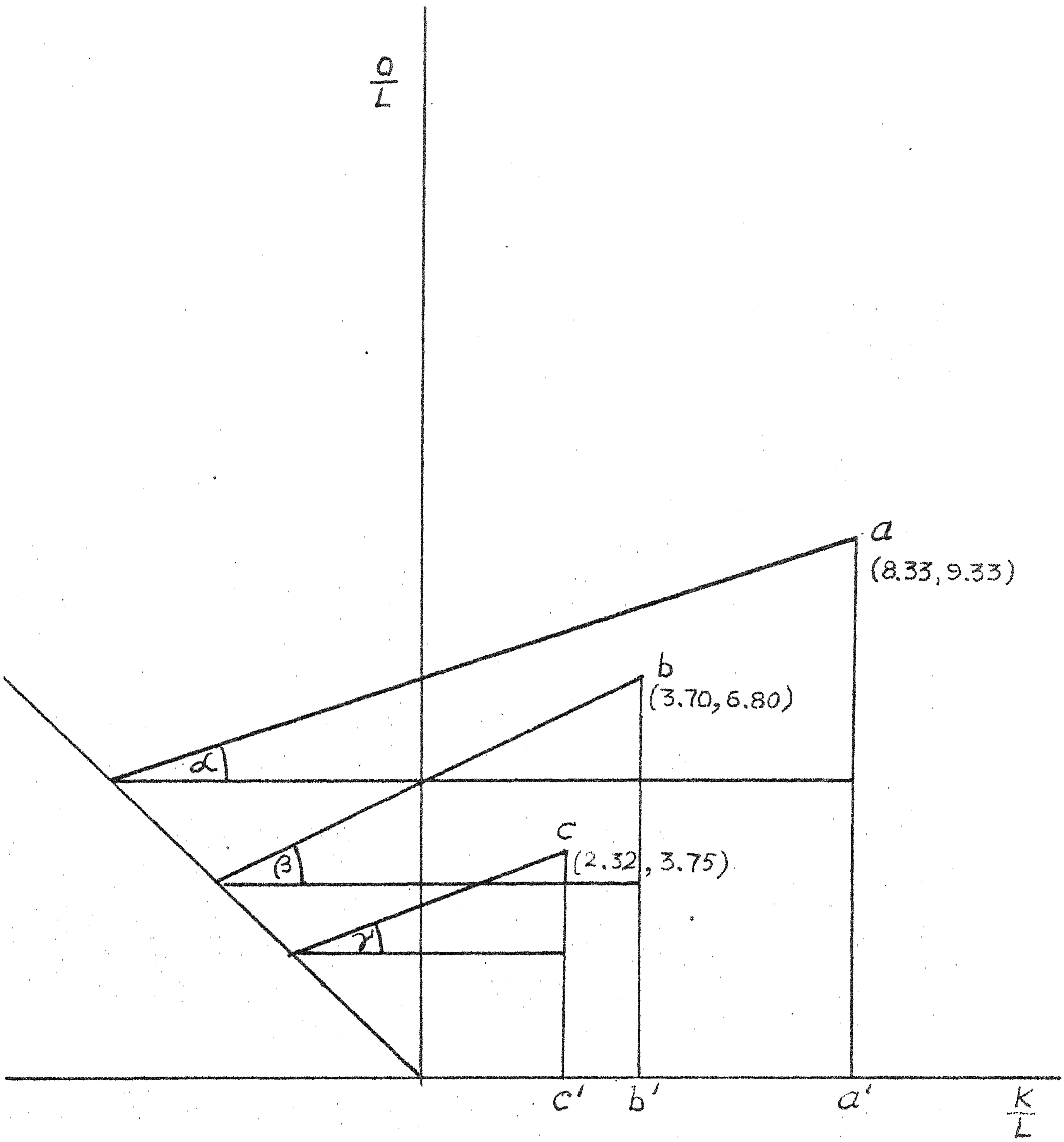

FIG. 6.1

B

Schedule of FIG. (6.1) and (6.2)

	α	β	γ
	56	34	30
	50	18.6	18.6
	6	5	8
	30.40	16.76	16.66
	9.33	6.80	3.75
	8.33	3.70	2.32
	5.07	3.35	2.08
	1.84	2.03	1.80
$= \omega$	1.64	1.1098	1.11
$\frac{PC}{L}$ / $\frac{PC}{L}$	$0.318 = \tan\alpha$	$0.489 = \tan\beta$	$0.379 = \tan\gamma$

2

$\frac{K}{PC} =$
Organic Composition of capital

VII

Implication for Policy

In conclusion we would like to point out that a number of policy prescriptions follow from the present study. They relate primarily to :

i) Optimum distribution of fertilisers and

ii) Diffusion of the optional technology among farmers.

There are also some wider implications.

Optimum distribution of fertilisers

Analysing the response of crops to fertilisers we have found that the critical point is at those dose at which diminishing returns set in. This is the minimum dose which will be effective and since fertilisers will be a scarce resource in the foreseeable future this dose is all we can hope for. If more than this requirement is ever available we can increase the dosage, though naturally never beyond the summit point. It follows that the amount of fertiliser fixed as a State or for that matter as a district quota ought to be calculated in several stages as set out below.

a) Frist: crop response functions as discussed above should be worked out for the major crops, including at least five or six of the common cultivars (e.g. say Kalyan Sona, C 306, PV 18, Sonalika etc. for wheat) for each agro-climatic region. In the first instance this should be done for the major nutrients N, P and K. For every species of every such crop chosen, the dosage of nutrient at which diminishing returns starts to operate should be established. It may be noted here that the natural soil fertility must be taken into account. Interaction between nutrients or due to crop rotation may be ignored as an impossible refinement at the present state of administrative infrastructure.

b) At the second stage we make an estimate of the total fertiliser required in a district in a particular cropping season (say Kharif) from the acreage sown to these crops. Since acreage varies from year to year due to variation in weather, changes in crop-selection due to changed prices of inputs and outputs, and even due to the farmers' personal circumstances, the estimate will necessarily be a very rough one.

(c) At the third stage, targets may be fixed and the fertiliser requirement adjusted accordingly. Caution should be exercised as unrealistically high targets will lead to unutilised fertiliser quotas.

(d) It may be possible at this stage to enforce the choice of one or two cultivars of a particular crop, including the complete package of practices, for each agro-economic region, particularly since H.Y.V. seeds are provided by government agencies. However, the soil and groundwater characteristics of individual farms within even small regions vary widely and changes in the timing and quantum of rainfall are unpredictable. Therefore, such an exercise in fraught with great risk. What must be calculated however, is the suitable cultivars for early or late sowing and their fertilisers doses, since action must be taken peremptorily if for instance the rains fail.

(e) Finally there should be a follow-up of the extent to which fertilisers were applied in the correct doses for the crops selected, and

whether complementary inputs like water were supplied adequately and in time.

The newly introduced formula of the Government of India leaves much to be desired in this context. No doubt, averaging out is the best that can be attempted, but even this could be improved by using a more rational method for converting area cropped into standard acreage. This could be done by using the recommended fertiliser doses on land of standard fertility as a conversion factor. For instance if H.Y.V. wheat uses 40 kg/ha of N, and gram uses 10 kg/ha while tall traditional wheat uses 20 kg/ha the conversion ratio becomes 1:0.25:0.5. This method would therefore, require to have different conversion factors for the different nutrients, but this complexity is not too great, one hopes, for the bureaucratic mind.

Another addition to current practice would be to run a subsequent check on whether the acreage was actually sown to the designated crops. The average yield of crops could also be used as a crude check on where the fertiliser doses were misapplied, with prosperous farmers using too much and the others

too little. Since sociological problems might arise here, a third policy change might be advocated, viz. the district fertiliser quotas could be partially dependent on the marketed surplus of the previous year, thus providing both an incentive and a test of effort. We are not going into further refinements, as we need feasible solutions for policy, not counsels of perfection.

Diffusion of Optimal Technology

The whole question here boils down to a change not only in the pattern of behaviour but even in the value system of the farmers, since adaption of "modern" technology in a value. A social phenomenon like this is difficult to change; nor indeed do we wish to change it wholly however irrational it may appear in some cases. After all our farmers' flexibility and commitment to modern ways is to our long-term advantage. Nevertheless at this point of time the use of what we have called α technology is socially undesirable, gives much less return in terms of scarce capital and prime cost and has a low employment potential.

We must realise, however, that no matter how

high the social costs of tractorisation may be, the farmer is not merely indulging in some kind of conspicuous expenditure arising from an international demonstration effect. For the individual a number of considerations operate, and his choice is rational. What he is seeking is not maximum returns but only reasonable returns with minimum risk. Tractors help minimise the effects of the vagaries of the weather, and equally important, they make him independent of hired labour, which frequently involve managerial problems. Easy credit for agricultural purposes has made the task of finding savings easier, while tractors may provide valuable supplementary income if hired out. Of course, they do break down, so the trusty bullocks are still maintained for emergencies — and this is psychologically our strongest point. None of the farmers in Haryana have completely given up the traditional techniques, and there is no reason to suppose that those of other States have been more precipitate in their mechanization experiments.

If we are to extend the use of the technology

which we have here found to be the most efficient however, a number of basic changes in policy have to take place. technology also requires improved tools which can be maintained, if not made, by the village blacksmith. There is a real urgency in solving the problems of design. Occasional awarding of prizes is not enough. Prototype must be constructed and their use subsidised. If grain-dryers and threshers--- not necessarily powered by electricity or diesel--- are physically available and credit is cheaper for them than for tractors, farmers may find that with quick drying of grain, quick harvesting is less necessary. Thus investment in rural infrastudture is essential. With assured water supply, there will be no waiting for rain and no hurry in seedbed preparation. With publicly organised crop protection(coordinated pesticide and insecticide spray) as well as crop insurance by L.I.C. and others, the costs of β technology in terms of risk and initial credit requirements may no longer freighten away the farmer using γ technology. To wean the α technology user away from his tractor may be much more difficult. Land ceilings, by breaking up

the larger holdings, may have a coercive effect. A penal Agricultural Holdings Tax would probably not work, as the rates at which it would be effective are politically too high. In any case, since operational holdings are being considered, the chances of concealment are extremely great. Perhaps we should try an indirect method- educate the extension workers out of a hankering for "modern" techniques, and take a second look at our investment in tractor production.

Wider Implications for Policy

The conditions for the successful use of fertilisers for optimising the production of foodgrains, as analysed in this study, lead to a number of implication for Government policy. It is obvious that the major requirements for success are:

(a) The availability of adequate inputs suitable for each soil climatic region, and

(b) their co-ordination with almost split-second timing.

As to inputs, the major constraint is the availability of water. This study working, as it does, mainly with High Yielding Varieties of wheat and rice recommends that fertiliser use should be strictly rationed, according to water availability in most cases. After all, even ordinary dwarf wheat needs at least 5 irrigations in Haryana. With increase of nitrogenous fertiliser doses, 2 or 3 more irrigations needed. Before the distribution of fertiliser is made, according to the high dosage recommended here, we should ensure that we are not dealing with the so-called irrigated areas where water is not assured, for instance, a tail end of canal system or a low discharge tube-well. The seasonal rainfall will, of course, have to be taken into account. If we do not do this, the response to the nutrient may be reduced to as low as 60 per cent and there will be far more risk to the crop. In the case of rice, water management will have to include drainage, if we are to prevent lodging with high fertiliser doses. It goes without saying that

both types of water management require a dependable source of power. While diesel pumps may do for individual farms, an irrigation system is dependent on electricity. Therefore, before embarking on ambitious programmes of increased N fertiliser doses, the available electricity during the period has to be taken into account.

Of the other ancillary inputs, High Yielding Varieties of seeds is the most important. In the case of Haryana, it has been suggested that Basmati Rice though not a High Yielding Variety, has a fairly good nitrogen response and should be included in the calculation of fertiliser distribution because it is rapidly becoming a very important export.

The fertiliser requirement is usually calculated according to the actual sowing of HYV but initial coverage of HYV may be larger than the ultimate coverage because of problems of survival. Since N is normally used in split applications, i.e. 2 or 3 applications in the

growing period, it will be more appropriate to adjust the amount of fertiliser held in each area after the crop had had time to mature somewhat. On the other hand, once HYV target has been fixed, the fertiliser complementary to it should be held in stock at the time of seedbed preparation. It is only after the first four weeks of sowing that further adjustments can be made.

While calculating the amount of fertilisers stocked at distribution centres before each sowing season, the following points should be considered. We have seen earlier in this study that the response of wheat and rice yield to successive fertiliser doses increases at first before levelling off and then declining. In case it is not possible to supply optimum doses of fertiliser for all farms in the region, the policy should be to supply at least the minimum dose (i.e. that at which the marginal product ceases to increase) to the farms. Spreading the fertiliser doses thinly is not optimum and it may be necessary to select some farms on which the fertilisers should be concentrated. Table 5.5, 5.7

5.5, 5.8, 5.10
Tables are worked out to show the response of rice and wheat respectively in terms of kg. of output per kg. of nutrient. Thus, assuming that the yield of unfertilised rice in irrigated areas should be 100 kg/ha and 700 kg/h for un-irrigated areas, an average of 6.7 kg/h/N in U.P. makes no impact at all. Perhaps it it had been possible to concemntrate the total fertiliser input on a smaller area, kg/kg/ha response would have been comparable to Haryana if not to Punjab. For the same reason, the fertiliser quotas to States like Haryana and Punjab should rise since they have higher response of yield to fertiliser. As a matter of policy, norms should not be fixed for States, but for agronomic regions.

It is interesting that as observed during interviews the farmers themselves seem to have a clear perception of the point below which it is preferable to use no chemical fertiliser at all rather than just a little. In a number of interviews, particularly in Ambala district,

where for wheat grown on un-irrigated land fertilisers are used, the farmers insisted that if they were unable to afford or obtain at least 40 kg/kg/ha of N they preferred to switch to traditional cultivars and technology on at least a part of their land rather than apply fertiliser doses, of say, 20 kg. per hectare. The farmers with comparatively large holdings would raise different combinations of crops growing some dwarf wheat, but smaller farmers generally did not use the HYV technology at all.

The testing of soil samples and balanced fertilisation between N and P_2O_5 as well as the residual and cumulative effect of use of fertilisers in crop rotation are also important parameters. For instance at a ratio of 2: 1 of N= P, in Ludhiana, it was found that average yield of wheat was about 3 tonnes per hectares compared to about a little over 2.3 tonnes other district where N : P ratio was either 3:1 or 4:1. The residual effect of fertiliser use with crop rotation has also been shown in ~~Figure~~ Table 5.1 , 5.6

As regards pricing policy, it has been noted that the farmers desire a cost benefit ratio of 1:2.5

for rice and 1:3 for wheat. In 1976, the ratios were much less, at 1 : 1.9 and 1 : 2.54 respectively. We have to recapitulate that almost at constant prices the fertiliser consumption in India more than doubled every five years upto 1971-72 but due to global shortage of fertilisers in 1972-73 and 1973-74, the rate of growth of consumption fell by 2.6 per cent and 5 per cent respectively compared to the previous years. With improved availability, however, in 1974-75 the demand did not increase but continued to drop by about 9.3 per cent compared to the previous year. Prices, of course, were not the only consideration. A study of the situation would suggest a number of other inhibiting factors, eg. aberrant climate, physical control of fertiliser distribution and inadequate credit availability. But then, the year 1975-76,had excellent water, drop in prices in fertilisers and withdrawal of physical control of their distribution. Nevertheless, the growth of consumption was only 12.4 per cent from the extremely low figures of the previous year.

The controversy as to whether fertiliser demand is more elastic to credit availability than to price is still going on. A further suggestion is that subsidies are more important than price cuts. The evidence is mixed. For instance in Punjab, in 1975-76 the consumption of phosphate fertiliser increased by 100 per cent due to subsidies on them but looking more closely we find that the bulk of the increase was accounted for by D.A.P. and S.S.P. which worked out at Rs.3.50 per kg. of P where the other phosphates cost Rs.6 or so.

The ideal price policy would, therefore, have to adjust the prices of input and output in such a manner that small farms are viable. This would require us to find out the cost of the subsidy which would be needed when the prices of food and fertiliser change from year to year. The viability of small farmers are beneficial in three ways. First, as we have seen, the intensity of land and labour used is greatest for small farms. Second, the marketed surplus increases for even small increase in production as their own consumption is

kept very low. Third, higher income for this category of farmers is probably the best way for ensuring social justice for them. Incidentally, our cost calculations confirm that the size of the viable farm is quite low at 4 -5 ha. This is very relevant for fixing the land ceilings and it provides an economic base to land reform. Here we have noted that with cheap credit and satisfactory availability of inputs, even a 2½ ha. farm can be viable.

We should also be aware of the limits of fertiliser use and the dangers of environmental pollution. In the case of Haryana which is fairly deficient in soil nitrogen, we have advocated comparatively higher doses of nitrogenous fertilisers per hectare, specially for High Yielding Varieties of wheat and rice.

Consequently, we anticipate a rise in the use of these nutrients. We should be aware in this context of the dangers of environmental pollution from the increased use recommended by us. The experience of Punjab will be relevant because of the intensive use of fertilisers and also because the agro-climatic factors are largely

similar. The reaction of farmers to changed input combinations as a result of the new technology is also likely to be similar.

The average use in 1969 in kilograms of N, P_2O_5 and K_2O per hectare of arable land was 41.2 world-wide, 10 kg in India and 45 kg in the Punjab. The fertiliser application rate(kg/ha/year) in Punjab increased from 0.8 in 1960-61 to 79.5 in 1972-73. The use of fertiliser in different districts of Punjab varies greatly, the highest being in Ludhiana, with an average use of 157 kgs. of nutrients per hectare of which 98 kgs. are nitrogen. A study conducted by Singh and Sekhon(1974) found that nitrate pollution of ground water was quite significant in Punjab. This is unfortunate as most of the farm families consume some ground water and thus fertilisers may prove to be a health hazard. From this point of view, fertiliser phosphate is not as important because it is held tightly in the soil and does not move downwards to reach ground water.

Depending on the rate and method of application, the kind of crops and soil and climatic variables, 35 to 60 per cent of the fertiliser N

applied is usually recovered by the crop. 10 to 20 per cent of the nutrient may volatilize into the atmosphere. The remainder may move into the ground water. The situations most conducive to nitrate leaching thus involve periods when rainfall exceeds evapo-transpiration or where unscientific methods of irrigation are practised, land is planted to shallow rooted crops and soils have low water holding capacities.

It follows, therefore, that the situations observed in Punjab are likely to be experienced much earlier in Haryana because irrigation is practised intensively on fertilised land, the soil is comparatively light and friable though, fortunately, major crops like wheat and maize are both deep rooted.

We conclude that the recommended fertiliser doses must be combined with lighter and more frequent irrigation schedules and careful timing of nitrogen applications. It has also been shown by Singh B and Sekhon G.S.(Plant & Soil,1976) that balanced application of N, P & K can significantly reduce minimal chance forpotential ground water pollution.

Current policy followed or advocated by the Haryana Government with regard to agriculture takes the form of production programme for rabi and kharif seasons separately. Rabi is traditionally the main season for growing foodgrains in Haryana and the rabi foodgrain crops cover an area of 60 per cent of the total acreage and contributes 70.5 per cent to total food production and wheat alone accounts for 52 per cent. The strategy for increase in production takes the form of stating district-wise targets both for area and production. These are conveyed to field level works by the first week of October, that is to say, roughly 2 or 3 weeks before sowing is due to start. The thrust of the policy is upon the important agronomic practices which may be set out as follows:

(1) Increase in the use of HYV by greater supply of certified seed of the preferred varieties and ensuring seed treatment against diseases. Certified seeds are produced at Government farms. The supplies of the HSDC(Haryana Seeds Development Corporation) are supposed to reach distribution centres by the 15th September; their storage is done by HAFED(Haryana State Co-operative Supply & Marketing Federation) at 140 branches of the

Central Co-operative Banks in the State.

(2) Method and the period of sowing and use of higher seed rate and fertiliser doses in case of late sowing is communicated to the farmers.

(3) Irrigation: Here the timing of release of the canal water is emphasised.

(4) Fertilisers: At present, the Government of Haryana is encouraging the application of phosphatic and potassic fertilisers and zinc sulphate since the use of nitrogen is already quite popular. Fertiliser distribution targets are given separately to district level and block level workers and the off-take of fertiliser is reviewed from time to time. When the offtake does not go up, the block level workers are expected to report, adduce reasons and suggest solutions. The second emphasis is on training and demonstration programmes which take place in November when the fertiliser distribution targets are also given out. The kharif crop has a smaller target for food grains of which the major product is rice. The cash

crops like sugar-canc and cotton are important in this season. The production programme, therefore, concentrates on the latter but in the traditionally rice growing areas of Ambala, Karnal Kurukshetra and Jind efforts are under way to put more areas under tall varieties rather than HYV because of danger of damage by flood.

Ancillary policies include soil testing campaigns and the supply of agricultural credit with suitable target distribution.

The programme, as it stands, is ambitious but since it is time bound it has succeeded reasonably well. The emphasis on crop diversification for the last 2 or 3 years is evident in this action programme but it is the result of extension work by Haryana and Punjab Agricultural Universities as much as by the Government. However, in matters of fertiliser doses recommendation, it is HAU which is the final authority.

Certain aspects of Haryana's policy need to be reconsidered, though when things go wrong it is not policy but implementation. In short, there is a lack of co-operation between the various

departments of the State Government which impinge upon the farmer. A simple example will suffice. When powercuts were the order of the day in the Bhakra Nangal system, all the districts were given the power in strict rotation for three days a week. The Agriculture Department pointed out that some districts had earlier sowing and needed the power for irrigation continuously for a week, while other districts had later sowing and could wait their time. The power engineers refused to change their rota. Similarly the figures of net irrigated area are shown as much higher in the Irrigation Department statements than in the Agriculture Department, which claims it is showing only genuinely available adequate water supply. There ought to be a small high-powered body which can compel all these officers to work together.

The policy of the Government of India has already been commented upon. In 1978 the procurement price of wheat and rice has been raised slightly, but since the bonus for procurement has been taken away, the situation is substantially the same as last year. A free market in grain suggests that prices may stabilize or even

go up, but this will not benefit the small farmer, whose access to the market is severely limited by transport problems. Haryana is lucky to have an extensive network of rural roads, but others will not be so lucky. The fertiliser distribution mechanism is also unsatisfactory as taxes are high and sales tax must often be paid to States when supplies are in transit. A tax credit for such double taxation is a must.

We conclude that a rational fertiliser policy is yet to evolve, but is well within the bounds of feasibility.

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